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RADIO FREQUENCY SPECTRUM MANAGEMENT

by

Edward Joseph Sujdak, Jr.

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RADIO FREQUENCY SPECTRUM MANAGEMENT

E. J. Sujdak, Jr.
Lieutenant Commander, United States Navy
B.S., Ohio State, 1969

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This thesis is a study of radio frequency spectrum management as practiced by agencies and departments of the Federal Government. After a brief introduction to the international agency involved in radio frequency spectrum management, the author concentrates on Federal agencies engaged in frequency management. These agencies include the National Telecommunications & Information Administration (NTIA), the Interdepartment Radio Advisory Committee (IRAC), and the Department of Defense (DoD). Based on an analysis of Department of Defense frequency assignment procedures, recommendations are given concerning decentralizing military frequency assignment by delegating broader authority to unified commanders. This proposal includes a recommendation to colocate the individual Service frequency management offices at the Washington level. This would result in reduced travel costs, lower manpower requirements, and a common tri-Service frequency management data base.

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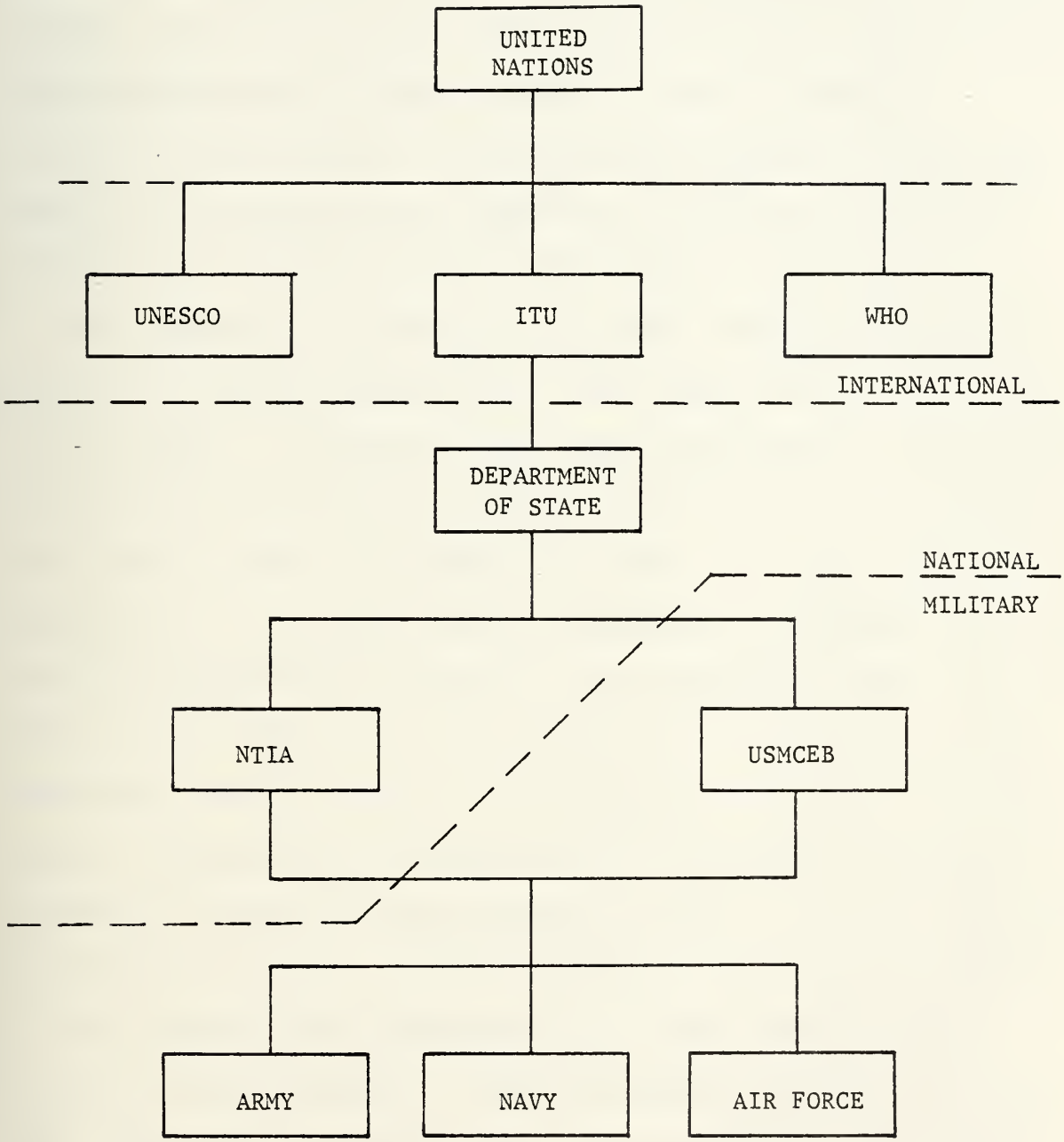
I. INTRODUCTION

This thesis presents a study of the structure of radio frequency spectrum management in the United States from a military perspective.[1] The purpose of this study is to evaluate the effectiveness of the current structure with a view toward recommending improvements. The management of the spectrum is divided into three major levels: 1) the International Level, 2) the National Level: Non-Military, and, 3) the National Level: Military. Figure 1 shows an overview of these three levels. In this figure the interactions between the International Telecommunication Union (ITU), the Department of State, the U.S. Military Communications-Electronics Board (USMCEB), and the National Telecommunications and Information Administration (NTIA) are indicated. These lines do not indicate control within the hierarchy, but rather the flow of recommendations to and from the international forum for the purpose of radio frequency spectrum management (this term will be defined later). The lines between the NTIA-MCEB and the military departments are indicative of a control function in spectrum management.

The radio frequency spectrum is a man-made natural resource. It is man-made in the sense that the extent of the usable spectrum is limited only by man's ability to techologically employ radio frequencies. Otherwise it has the characteristics of a natural resource. The radio frequency



Frequency Management
Hierarchy: Overview
Figure 1

spectrum is finite and is not exhausted through use nor does it become worn out. As with other natural resources, careless use can pollute it and prevent the extracting of maximum benefit from the spectrum. The radio frequency spectrum ranges from ten kilohertz (10,000 hertz) to three terahertz (3,000,000,000 hertz).[2] Of this broad expanse of radio frequencies only about forty gigahertz (40,000,000 hertz) is allocated for radio usage by international agreement.

The demand for the use of the radio frequency spectrum has grown steadily since 1935. The incentive for this growth in the number of spectrum users and, consequently, the number of separate frequencies in use can be linked to the growth in per capita income, the changes in taste, and the levels in population. Like other natural resources the demand for spectrum has produced an increase in the available supply of spectrum in two ways: 1) at the extensive margin and 2) at the intensive margin. First, the technology to operate at higher (newer) frequencies has expanded the quantity of spectrum; an increase in supply at the extensive margin. Second, technology has permitted closer channel spacing, e.g., the utilization of more channels per frequency band. This has been done through the development of technologically improved transmitters, receivers, antennae, etc. These technological improvements facilitate closer channel spacing because of narrower frequency tolerances. This is an increase in the supply of spectrum at the intensive margin.

The supply of spectrum is, therefore, largely determined by technology, but management and economics also play important roles in determining the supply of spectrum.

First, technology may increase the supply of spectrum, but management of the spectrum improves its use in time, space, and frequency. Spectrum management is concerned with the problem of the spectral dimensions of time, space, and frequency. Signals transmitted on a specific frequency occupy all three spatial dimensions. The degree to which the physical space through which the signals pass is in fact occupied depends upon the radiated power. Extreme power will so saturate physical space so as to prevent any other signal from being intelligibly received within it.

To illustrate, two spectrum users may simultaneously transmit on the identical frequency if sufficiently geographically separated. Because of their geographic separation, they occupy different spectrum in the spatial sense. If, however, they are not geographically separated and transmit on the same frequency and with the same power, but at different moments in time, they occupy different spectrum in a temporal sense. However, if they transmit with the same power at the same time and are not geographically separated, they occupy the same spectrum.

Second, economics plays an important role in determining the usable supply of spectrum. The cost of the technology required to utilize higher frequencies or to utilize more closely spaced frequencies may limit the economic usability

of the supply of spectrum. Thus, the high cost of technology to utilize higher frequencies effectively limits the spectrum supply available for apportionment among users.

In essence, technology provides the physical supply of spectrum, management concerns itself with the apportionment of that supply, and economics measures the economic usability of the supply of spectrum.

Radio frequency spectrum management concerns itself with the control of the spectrum resource. Radio frequency spectrum management involves the managerial activities of:

1) formulating plans for the use of the spectrum and executing controls over users of the spectrum,
2) structuring tasks for management of the spectrum and making decisions about managing the spectrum,
3) communicating information and policy about decisions concerning frequency management,
4) dealing with conflicts over how the spectrum is to be used and by whom,
5) maintaing stability in spectrum management practices,
6) controlling change activities in spectrum management, and,
7) apportioning resources among competing needs.

Two important aspects of resource apportionment are assignment and allocation. Allocation may be thought of in two ways. First, allocation may be viewed as the designation of a band of frequencies to a specific telecommunications service such as maritime mobile, fixed broadcasting, aeronautical navigation,

amateur, etc. This first view of allocation implies the existence of no specific spectrum user or constraint of particular frequencies to a particular geographic area. Second, allocation may be viewed as the designation of a band of frequencies and a specific service application to a given user or particular geographic area. In this thesis allocation has the latter meaning.

On the other hand, assignment is defined as the designation of a specific frequency within an allocation for a specific user of communications electronics equipment. Assignment implies some property rights to the user of that frequency to the mutual exclusion of other users.[3]

As stated, there is a distinction between assignment and allocation although some sources use the terms interchangeably. A further distinction between assignment and allocation is that allocations are made at the international level while assignments are made by individual nations. Assignments are designed to be made in accordance with a national allocation plan which is a subset of the international allocation plan. Radio frequency spectrum management involves the allocation and assignment of radio frequncies. The term management, used in this sense, is the attempt to control the utilization of the spectrum in order to obtain the greatest benefit for the greatest number of people.

In essence, the real task of radio frequency spectrum management is the assignment and allocation of radio frequencies that minimimzes harmful interference while providing

telecommunications services at the lowest possible cost. A major function of spectrum management is to alleviate the growing congestion in the spectrum which leads to mutual interference. At the same time it must provide effective, rapid, and reliable telecommunications services.

First, alternatives to the use of radio frequency can be found, such as cable, transportation, optical fibers, etc. Second, the extensive margin of the spectrum can be developed by making more economically usable new frequencies available for users. Currently this is being done by developing higher frequencies for use. Third, the intensive margin can be developed by technologically improving transmitting equipment, using directional antennae, and using more sensitive receivers to detect more closely spaced frequencies.[4] And finally, as an alternative to using more closely spaced channels, frequencies which are normally used for long-range communications can be used for short-range communications.[5] Frequencies in the high frequency band (3-30 megahertz) are normally used for long-range communications. However, at certain times of the day their propagation characteristics make long-range communication on these frequencies impractical. During this period of the day these frequencies can be used successfully for short-range communications. This is essentially a time-sharing approach to expanding the supply of spectrum.

The author intends to discuss how the radio frequency spectrum is managed in the United States. The relationships within the frequency management hierarchy will be explored with an emphasis on its structure.

The thesis begins with this brief introduction and then breaks the frequency management hierarchy into three basic levels. Chapter Two explores the International Telecommunications Union (ITU) and its efforts to manage the spectrum through mutual international cooperation without the force of laws and regulations. Chapter Three looks into the United States spectrum management hierarchy with emphasis on the Federal Government's non-military spectrum management hierarchy. Chapter Four explores the military's spectrum management hierarchy and proposes a change to the current hierarchy.

II. INTERNATIONAL ORGANIZATION

In this chapter the author will discuss the international level organization, the International Telecommunication Union (ITU). Figure 1 shows the position of the ITU in the frequency management hierarchy. For the purposes of this thesis, frequency management is defined as the control of the radio frequency spectrum through the process of frequency allocation and assignment, surveillance of equipment research & development, and frequency usage records. This discussion will show how the ITU has changed from a technically oriented association to one whose decisions are colored by economics and politics. Also the matter of how politics and economics have come to affect ITU allocations will be discussed.

A. ITU: TECHNOLOGY TO POLITICS

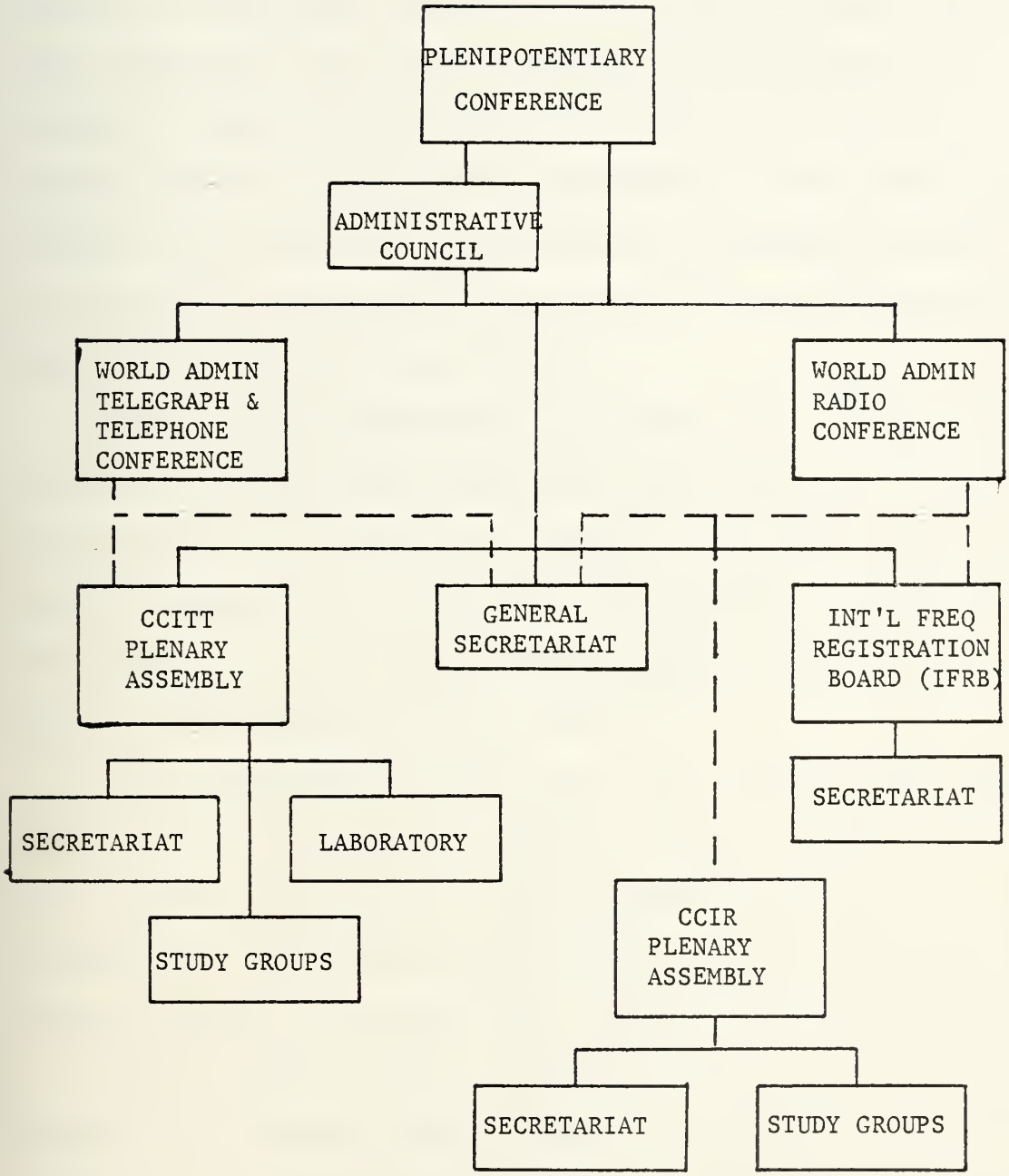
The International Telecommunications Union (ITU) finds its origins in two predecessor associations, the International Telegraph Union (founded in 1865) and the International Radiotelegraph Union (founded in 1906). These two organizations combined in 1932 to form the International Telecommunication Union. The ITU, like its predecessors, is a voluntary association of independent countries formed to enhance the conduct of international communications. It is voluntary in the sense that nations could confine their communications within their own national borders, but because of commericial and political reasons, they choose not to do so. When communications

cross borders only international cooperation can assure that they will reach their destination. Even adversaries find it helpful to communicate, for example, the USA/USSR Hot Line.

The representatives of ITU member nations meet periodically and draw up, by mutual agreement, rules, regulations, and recommendations for the conduct of telecommunication services. The ITU consists of various technical committees and working groups. Figure 2 shows the ITU organization structure. George Codding, noted expert on the International Telecommunication Union has stated that the Consultative Committees of the ITU are the organs in which the greatest amount of purely technical work is accomplished and where there is usually free exchange of ideas unhampered by political considerations.[6] These groups consist of telecommunication experts from both the private and public sectors of the member nations.

The history of international communications organizations has been divided into three periods: 1906-1957, Technological; 1957-1971, Transition to Political; and 1971-Present, Political.[7] The earliest period was marked by decisions concerning the technical aspects of communications such as the adoption of a standard design telegraph key, a standard telegraph code, technical standards for transmitters to reduce frequency drift and interference, licensing of operators, interface equipment standards, and the allocation of frequencies to various services.

During the period 1957-1971, the World saw many former colonies gaining their independence and emerging as a bloc called the Lesser Developed Countries (LDC'S). Joel M. Woldman,



ITU Structure
Figure 2

a Congressional Research Service specialist in U.S. Foreign Policy, suggests that the LDC'S quickly found that they wielded significant political power in the form of the New World Economic Order which they were advocating at the United Nations. The LDC'S, seeing themselves as the have-nots, began demanding a greater share of the World's resources. They viewed the technical domination of international telecommunications by the industrial nations as a deliberate effort to continue dominating and exploiting them.[9]

Woldman further suggests that since 1971, the LDC'S have emerged as a significant political power which has used the United Nations as a venue for pushing their case for a greater share of technology, resources, and capital. The LDC'S believe that these items have been monopolized by the industrial nations to the detriment of the LDC'S.[10]

In the telcommunications arena, for example, the equatorial countries (Brazil, Columbia, Congo, Ecuador, Indonesia, Kenya, Uganda, and Zaire) have claimed that they are the controllers of a very important natural resource, the geostationary orbital position for satellites. They claim that this orbit is a physical fact arising from the nature of the Earth, because its existence depends exclusively on its relation to the Earth's gravity, ergot, it is not outer space (which has been declared open to everyone by the 1967 Treaty on the Principles Governing the Activities of States in the Exploration and use of Outer Space including the Moon and Other Celestial Bodies). The equatorial nations argue therefore, that the

segments of the synchronous geostationary orbit are a part of the territory over which the equatorial countries exercise sovereignty. Geostationary orbit positions are a scare resource whose importance and, hence, value is increasing with the growth in satellite communications technology.[11] Therefore, these countries decided at Bogota in 1976[12] to defend their sovereignty over this potentially lucrative natural resource. In essence, they were demanding "rent" for the use of the geostationary satellite parking places[13] or demanding them for their own use. The LDC'S knew they did not have the technology to use them at the present time, but may have anticipated the purchase of off-the-shelf technology to support a satellite system of their own.

Another political issue is the flow of information between the developed and lesser developed nations. The LDC'S are concerned about the dominance of Western Nations over international news broadcasts. The LDC'S feel that they are, by and large, neglected in news coverage. The news that is carried tends to be unfavorable and unfair to them. They are demanding more control over news generated and consumed within their countries.[14] An example of this is the ordering of U.S. newsmen out of Iran during the later stages of the U.S. Embassy take-over in Tehran, Iran, in December, 1979. Some governments feel that their ability to control their citizenry and promote their own brand of chosen politics can be seriously jeopardized if that government cannot in some way regulate the communication system supplying foreign ideologies, i.e., the Voice of America and the Radio Free Europe broadcasts.[15]

Informed sources within the National Telecommunications and Information Administration voiced concern that extensive ideological rhetoric carried on at the General World Administrative Radio Conference 1979 (GWARC 1979) in Geneva could successfully prevent any meaningful confrontations from occurring, i.e., resolution of a U.S. proposal to increase satellite allocations.[16] In previous conferences the norm has been a harmonious exchange of proposals based on the technical expertise of the member nations. Recently, however, difficulty has been encountered in drafting new international frequency allocations.[17] Codding feels that this problem in drafting a new allocation plan is one of the most pointed examples of national interests placed ahead of effective technical control of telecommunication services.[18] No longer is it sufficient to demonstrate the technical feasibility of a proposal, but now it must be shown to be politically acceptable and economically advantageous to the majority as a selling point for acceptance of the proposal. This, however, can be a two-edged sword; the developed nations with heavy capital investment in certain portions of the spectrum would be unwilling to reallocate frequencies if their capital investment is rendered valueless in the process. Since the establishment of the United Nations one-nation, one-vote principle in the United Nation's affiliated bodies, and the growing number of newly independent LDC'S, highly technical issues have sometimes been determined on the basis of essentially political concerns.[19] Recently this has become a significant problem. Consequently, LDC'S with rudimentary

telecommunications systems and limited frequency requirements often engage in bloc-voting. Woldman believes the odds favor coalitions which sometimes form between LDC'S and communist countries.[20] These coalitions out number the developed nations which had previously dominated international bodies.[21] However, as Woldman suggests, this shift in voting power from the developed natins to the LDC'S can be beneficial for both parties. First, the developed nations may succeed in garnering the support of the LDC'S in achieving the goals of the developed nations. This winning of support can be achieved by providing technical assistance to the LDC'S. Second, the technical assistance will open the way for an increase demand for the telecommunications-electronics goods and services of the developed nations thus boosting their economy.

The politization of the International Telecommunication Union's function is highlighted by noting that in the past more weight has been given to the technical products of the Consultative Committees and agreements were reached on this technical basis. The ITU's response to the charge that there is a conscious or unconscious swing away from technology based decision-making by the ITU is best stated in their own words:

> The ITU's decision process is manned by technicians representing the specialists of the ITU. Presumably the national technicians interrelate in their home States before they engage the procedures and process of the ITU. The impression exists that the ITU in the totality of its operations is weighted more in the direction of technical feasibility than in the direction of a balancing of competing political interests. The ITU, although certainly not immune from the pressures of competing ideologies and the differing interests of the new and old States, is

> separated from the great concerns for the maintenance of international peace and security that reside in the U.N.[22]

The author believes that the import of this statement is that the ITU is trying to remain a non-political body that manages the radio frequency spectrum based more on technological considerations than on political-economic considerations.

Whether the agreements achieved in the ITU Consultative Committees are implemented by the member nations via politically-based methods or technology-based methods, these technical agreements are more appropriately dubbed recommendations rather than regulations because the ITU has no concrete authority for enforcing these agreements. One major factor influencing nations to abide by these agreements is the economic reality of possessing a system which is incompatible with other systems designed and manufactured to ITU standards. For example, a telecommunication network which is not manufactured or operated in accordance with international technical standards could not be integrated into a world-wide network and would be of limited use.[23] M. B. Williams suggests that, indeed, the long life and huge investments involved in telecommunications equipment, the differing practices and rates of development among various nations indicate no other way of proceeding with the definition of new techniques and of invoking the necessary compromise.[24]

The question of frequency allocation is a complex issue which involves the processes of politics, economics, and technology. To understand the process of frequency allocation,

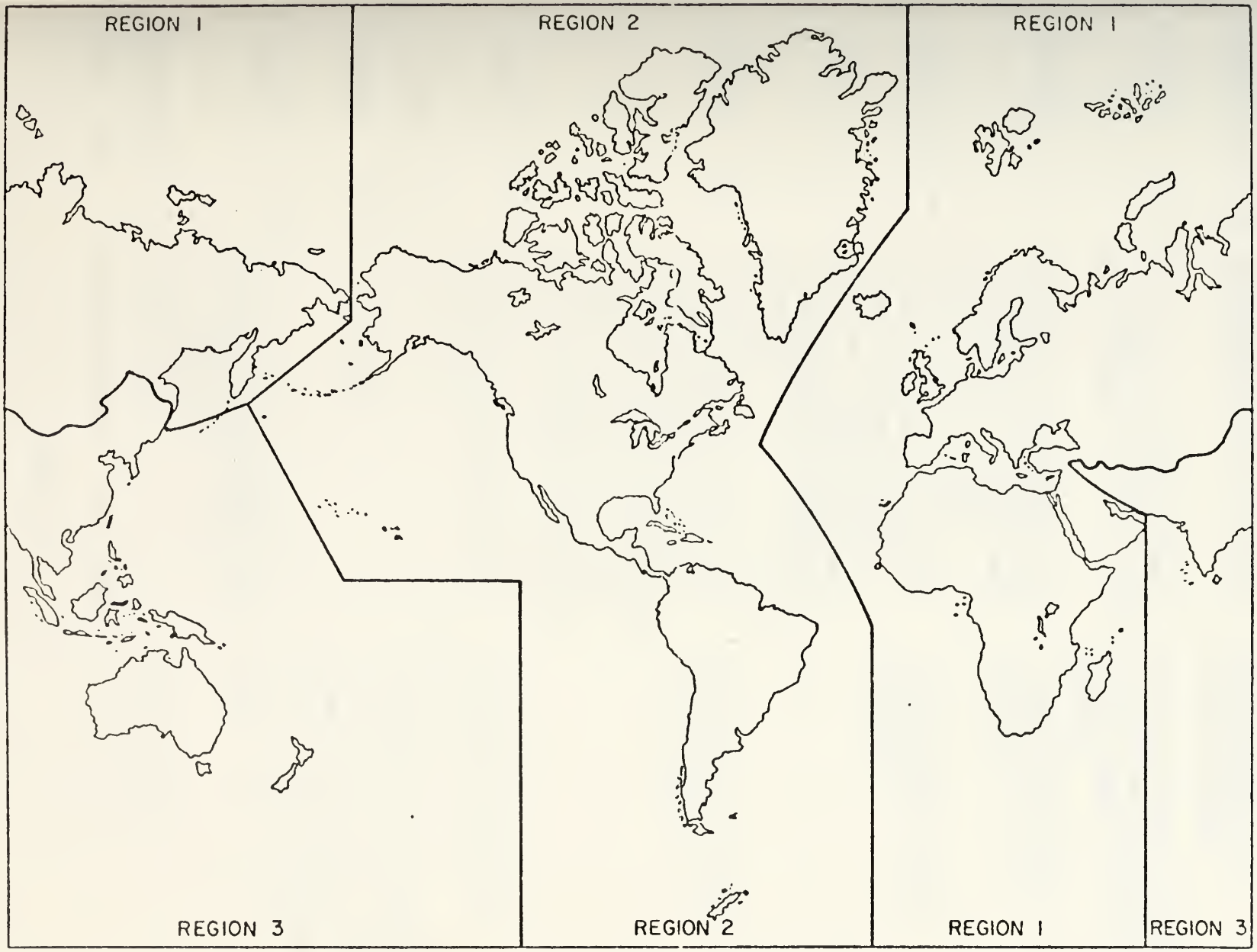
the construction of an adequate model of allocation in the existing political climate is necessary. The construction of such a frequency allocation model is beyond the scope of this thesis (see the Williams and Collins thesis[25] for one approach). The discussion will be confined to the concept of allocation stated in the first chapter and how frequencies are managed within the United States by the Federal Government and by the United States Military.

The next section will concern itself with ITU allocation of frequencies to services and the political problems associated with it.

B. FREQUENCY ALLOCATION: THE ITU VIEW

Frequency allocation involves the administrative division of the radio frequency spectrum into bands, and the classification of spectrum-using operations (communications, radiolocation, etc.) into groups called services.[26] These frequency bands are assigned to specific services on either a worldwide or regional basis. Figure 3 shows the current ITU regions. As an example, the Radio Regulations, the primary product of the ITU, allocates the 7100-73000 kilohertz band to broadcasting in Regions 1 & 3, but allocate the same band to amateur use in Region 2 (the United States and Possessions).[28]

A look at Figure 4 shows that frequencies have differing characteristics. Therefore, some are more suited to one radio service than another. For example, high frequencies (3-30 megahertz) are useful for low capacity, worldwide radio



ITU Frequency Allocation Regions
Figure 3[27]

PROPOGATION CHARACTERISTICS AND USES

Frequency Range	Band Code	Propagation Characteristics	Typical Uses
Below 3 kHz	ELF	Same as LF	Very long-distance point-to-point.
3-30 kHZ	VLF	Same as LF, except attenuation equally low day or night; very reliable.	Very long-distance point-to-point and especially fleet broadcast communications.
3-300 kHZ	LF	Primarily ground waves; low attenuation; reliable; daytime absorption of sky waves greater than at night.	Long distance point-to-point comm, marine, NavAids.
33-3000 kHZ	MF	Ground waves but some ionospheric sky waves; attenuation of sky waves low at night and high in daytime; subject to ground-sky wave interference for distances less than 500 n.m. especially at night.	Broadcasting, marine comm, NavAids, harbor telephone.
3-30 MHz	HF	Transmission over great distances depending solely on ionosphere; varies greatly with time of day, season, frequency and portion of solar sunspot activity cycle; subject to ground-sky wave interference at short distances.	Moderate and long distance communications of all types.
30-300 MHz	VHF	Sporadic ionospheric effects occur during high portion solar cycle.	Short-distance comm, television, FM broadcasting, NavAids.
300-3000 MHz	UHF	Same as EHF	Short-distance comm, radar, television, aero-Nav-Aids.
3-30 GHz	SHF	Same as EHf	Short/long distance comm, radar, relay systems, Nav-Aids, satellite comms.
30300 GHz	EHF	Substantially straightline propagation analogues to that of light waves; unaffected by ionosphere.	Radar, radio-relay-Nav-Aids.
300-3000 GHz		Same as EHF	Fixed, mobile.
Above 3 THz		Coherent waves, line of sight.	Fixed, mobile.

Figure 4[30]

communications, but are not useful for high capacity circuits or for television. Frequencies lower in the spectrum are useful for long-range search radar, but radio frequencies high in the spectrum are required for the detection of small cross-section targets. Ideally, frequencies should be allocated to services based on their characteristics. It is doubtful that the first allocation of frequencies to radio communications was based on their propagation characteristics.[29] It is highly probable that the frequency of operation of the first radio transmitter was more a matter of chance than conscious choice. In the earliest days of radio frequency communications technology limited transmitter frequency selection. The first radio transmitters were constructed at a time when little was known about the propagation characteristics of electromagnetic waves. Therefore, allocation of frequencies to the first radio communication services was more a matter of convenience than technology. This methodology has been self-perpetuating; increased frequency allocations for existing services were made in adjacent bands perhaps preventing more suitable allocation at a later date.

As the value of radio communications became more apparent, the demand for additional services (e.g. radiotelephone) and expansion of existing services grew. Other services were started at a time when technology could not adequately determine if the frequency band allocated to the service was technologically the most apropos for that service. The current political-economic climate hinders the allocation/reallocation

of frequencies based on technology, but demands the careful assessment of the political and economic implications of the allocations. It has proved impossible, in some cases, to allocate frequencies to the services for which they are technologically best suited. A possible cause is the potential loss of capital investment in equipment designed to operate on those frequencies. Even though the characteristics of a frequency may be well-documented, the movement of existing services from these bands to accommodate the technologically more suitable service carries too great an economic cost.

The ITU member nations, through mutual agreement, allocate frequencies to services by geographic regions. The ITU member delegations make frequency allocation recommendations based on technical considerations. But the actual allocations are made as a result of the political, technical, and economic justifications presented by these same member nations. These agreements have the force of treaty status when signed by the member nations. Any reallocation scheme must consider the economic impact on the capital investments in existing communication-electronics systems before reallocating the spectrum. Each ITU member nation is allowed to construct its conference delegation from both the private and public sector to encourage a balance of views presented at the conferences. This freedom allows both technical and economic expertise to be brought to bear on the conference agenda items. However, it is also noticeable that some nations have brought only their political bargaining team to Radio Conferences.[31] This has been true

especially in the case of the LDC'S who possess little technical expertise and can, therefore, compete only in the non-technical area.

The current allocation scheme strongly favors the developed nations. Frequency assignements within an allocated band are made on a first-come, first-served basis. The developed nations, having the sophisticated technology necessary to be first off the mark in claiming frequencies for use, got the majority of available spectrum within that allocation. Consequently, Regions 1 & 3 have been allocated portions of the spectrum which may prove to be unusable for many of the countries in those regions.[32] The easily usable portion of the spectrum in Regions 1 & 3 have been claimed by the developed nations in that area leaving potentially useless frequencies for use by the LDC'S. It is understandable that the LDC'S are demanding a change in this scheme which requires a change in the principle of frequency allocation. They are demanding that frequencies be allocated on a national basis.[33] In essence, the LDC'S demand that a portion of the spectrum be set aside, unused, until they are ready to use it.[34] It is not clear whether the LDC'S motivation is conscious or unconscious, overt or covert, toward stockpiling for future planned use, or for use as a source of income. However, the effect will be the same--administratively unusable portions of the spectrum awaiting use by a designated user.[35] Of particular attractiveness to LDC'S is the real potential for turning allocated frequencies into cash[36] by either leasing frequencies to users

(especially developed nations needing more spectrum space) or by enticing businesses to settle in LDC'S territory because of the promise of available frequencies.

In summary, prior to the emergence of the LDC'S as an ITU political power in the 1970's[37] the developed nations had claimed for themselves, through allocations, ninety percent of the spectrum.[38] The United States, in particular, was a leader in the development of technology and was able to get what it wanted at radio conferences by expert influence.[39] Allocation decisions were traditionally based upon a consensus of the most efficient and technically sound way to divide and use the spectrum.[40] The developed nations made heavy capital investments in equipment designed to operate within the frequency allocations they had formulated. However, the emerging Third World countries viewed colonialism as equivalent to economic exploitation, foreign capital, large Western corporations, and the capitalist system in general. To end colonialism, therefore, the exploited nations needed to acquire political independence and gain control over their economies, natural resources, and economic development policies. In their thesis Williams and Collins point out that the LDC'S saw modern telecommunications technology as their right and the radio frequency spectrum as a world resource to which they are entitled a share. Sophisticated telecommunication systems were perceived as a source of national pride and as weapons in the stuggle for political and economic survival.[41] Further, Williams and Collins point out that nations with a sophisticated worldwide communications

system are usually more attractive to foreign investors. The LDC'S perceive access to these systems and spectrum space as a source of revenue. The LDC'S see that the telecommunications systems of the developed nations have proved to be an economic resource for the developed nations. They, therefore, wish to do the same for themselves. The LDC'S, through bloc voting, have the power to gain access to these things on their own terms, i.e., frequencies utilized and technical/financial aid for telecommunication systems.[42] As previously stated the LDC'S may attempt to use bloc voting tactics to dominate future radio conferences to gain allocations favorable to their interests.

C. CONCLUSION

Ideally, the technical consultative committees and ad hoc working groups see themselves functioning free of outside pressures. However, the growing interdependence of the nations of the world and the desire of the LDC'S to share in the wealth of industrialized nations is forcing solutions to communications-electronics problems which may be technically infeasible, or, at best, on the very fringe of advancing technology. The technical experts and engineers are then assigned the responsibility to provide the mechanism necessary to implement the consensus solution. For example, in order to make more spectrum available for the burgeoning satellite technology, a portion of the spectrum in the 40 gigahertz range has been set aside for satellite up/down links. This frequency range is subject to severe attenuation by free space losses, oxygen molecule absorption, precipitation, etc. Additionally, lightweight satellite-borne

transmitters with sufficient power to overocme attenuation losses characteristic of this frequency range have yet to be built. From a technical standpoint the 10-14 gigahertz band is more suited to this use because the attenuation losses are less severe. Further, in Geneva in 1974, Third World Countries imposed an allocation scheme based on nationalism rather than technology. Countries without the economic and technical resources to send both a diplomatic and engineering team to the conference sent only a diplomatic team to secure their voting rights at the conference.[43] The developing nations dominated the non-voting technical gatherings as expected, but the LDC's were able to impose allocations without consideration of engineering, geographical, and operational considerations. The result was to encumber the coastal radiotelephone band with allotments to countries with no coastlines and the allotment of the same high frequency channels to as many as fifteen countries. These countries are in such close proximity that mutual interference is virtually assured.[44]

Balanced decision making (i.e., decision-making based on analysis of pertinent economic and technical factors) can be achieved by carefully counterpoising technology, bargaining, economics, and politics. It is difficult to specify the weight that should be given to any of these facets. The agreements resulting from such balanced decision-making must be of such caliber that no one nation or coalition of nations will want to opt out of the agreement. No nation or coalition of nations should be able to preceive that, as an individual or coalition,

they will benefit more by opting out than if they had remained with the majority.

Another problem facing the International Telcommunication Union (ITU) is a lack of planning for the future. The ITU appears to be following the well-established axiom of international affairs, the rule of immediacy.[45] In practice, this axiom says that changes take place incrementally and only in the face of adversity. Planning is often neglected because managers:

1) do not always think about the future;
2) are overly confident or overly pessimistic about the future;
3) are impatient and unable to delay gratification;
4) cannot overcome the situational constraints of a lack of time to plan, lack of information on which to base plans, etc.;
5) base incentives, rewards, and penalties on short-term performance;
6) transfer too frequently; and,
7) often leave planning to staffs instead of doing it themselves.[46]

In a World marked by growing interdependence of nations for sources of raw materials, markets for products, etc., the ITU cannot avoid making decisions and providing guidance to technicians. This guidance is necessary to help channel the power of technological innovation into providing the methodology for implementing solutions based on a balance of technology, economics, and politics.[47]

One way to free the ITU conferences from the non-technical issues which tend to divert the energy of the conferences from technical work is to implement a proposal made by the United States. The United States has long maintained that the ITU should be strictly a technical forum promoting improved telecommunications through the application of sound technology. The United States proposed that such issues as ITU membership, voting rights, and rights to geostationary orbit positions be left to the United Nations while ITU conferences are kept a technical forum.[48] The author feels that by keeping the ITU a strictly technical forum, devoid of non-technical considerations may tend to weaken the ITU. The technical organization already exists within the ITU's structure for dealing with issues amenable to technical solutions. The author acknowledges the legal and political arguments put forth in dealing with issues such as geostationary orbit positions, but he believes that the ITU has the necessary resources to decide the issue. However, the membership and voting rights issues may be more suitable for resolution by the United Nations. Further, the author speculates that the United States may see the ITU as a technical forum in which the U.S. wields significant influence in the form of technical expertise. Whereas in a more political arena the U.S. may perceive itself as having less influence.

The next chapter will discuss the Federal Government's role in frequency allocation and assignment in the United States & Possessions. The role of four major frequency management

agencies will be reviewed. Finally, a discussion of the centralization-decentralization of frequency management policy in the United States will be given.

III. THE NATIONAL ORGANIZATION

In this chapter the primary players involved in frequency management for the Federal Government will be introduced. Further, the rationale for the Federal Government's involvement in frequency management will be discussed.

The four major groups that will be introduced are: 1) The Executive, Legislative, and Judicial Branches of the Federal Government; 2) the Department of State; 3) the Department of Commerce's National Telecommunication and Information Administration (NTIA); and, 4) the Department of Defense (DoD). The role of the Department of Defense in frequency management will be discussed briefly here and in more detail in Chapter Four.

Also, the frequency coordination process at the National Level will be outlined. Finally, national telecommunications policy and the issue of its centralization-decentralization will be discussed.

A. UNITED STATES FREQUENCY MANAGEMENT

The allocation of frequencies to services falls into the broader activity called frequency management. Because the radio frequency spectrum is viewed as a natural resource, albeit a man-made one, it is appropriate to discuss the process of frequency allocation as a part of managing this resource.

The Federal Government considers the radio frequency spectrum to be a vital natural resource.[49] Any rights of users

within the United States to operate on any radio frequencies are rights held by the United States as a whole. Such rights are transferred by law by the Federal Government from one user to another in keeping with the National interest. This transfer of rights to use radio frequencies is handled by the Federal Communications Commission for the private sector and the National Telecommunications and Information Adminstration in the public sector.

Consistent with the right to use a natural resource is the obligation or responsibility to prudently use that resource--a process called resource management. Here resource management is defined as the process of making decisions about how resources should be used, by whom, and their distribution among competing demands. In this instance resource management is synonomous with frequency management.

In general, resource management is an essential role of the Federal Government. Therefore, frequency management is the responsibility of the Federal Government, especially since the Government is the largest single user of the radio frequency spectrum in the United States. Frequency management includes 1) the establishment of national frequency management objectives, 2) the formulation and promulgation of national frequency management policies designed to achieve the objectives, and 3) the implementation of these policies. Further, it encompasses the steps taken to supervise, regulate, and manage the use of the radio frequency spectrum to preclude and reconcile competing uses and demands upon the

spectrum. Simultaneously it is necessary to discover alternatives to radio frequency spectrum usage where feasible. This will relieve some of the congestion on the spectrum while conserving it for future use. Certainly, there are legitimate reasons for using the spectrum, but many new and existing circuits could be adequately accommodated on existing common-user circuits vice establishing new circuits.

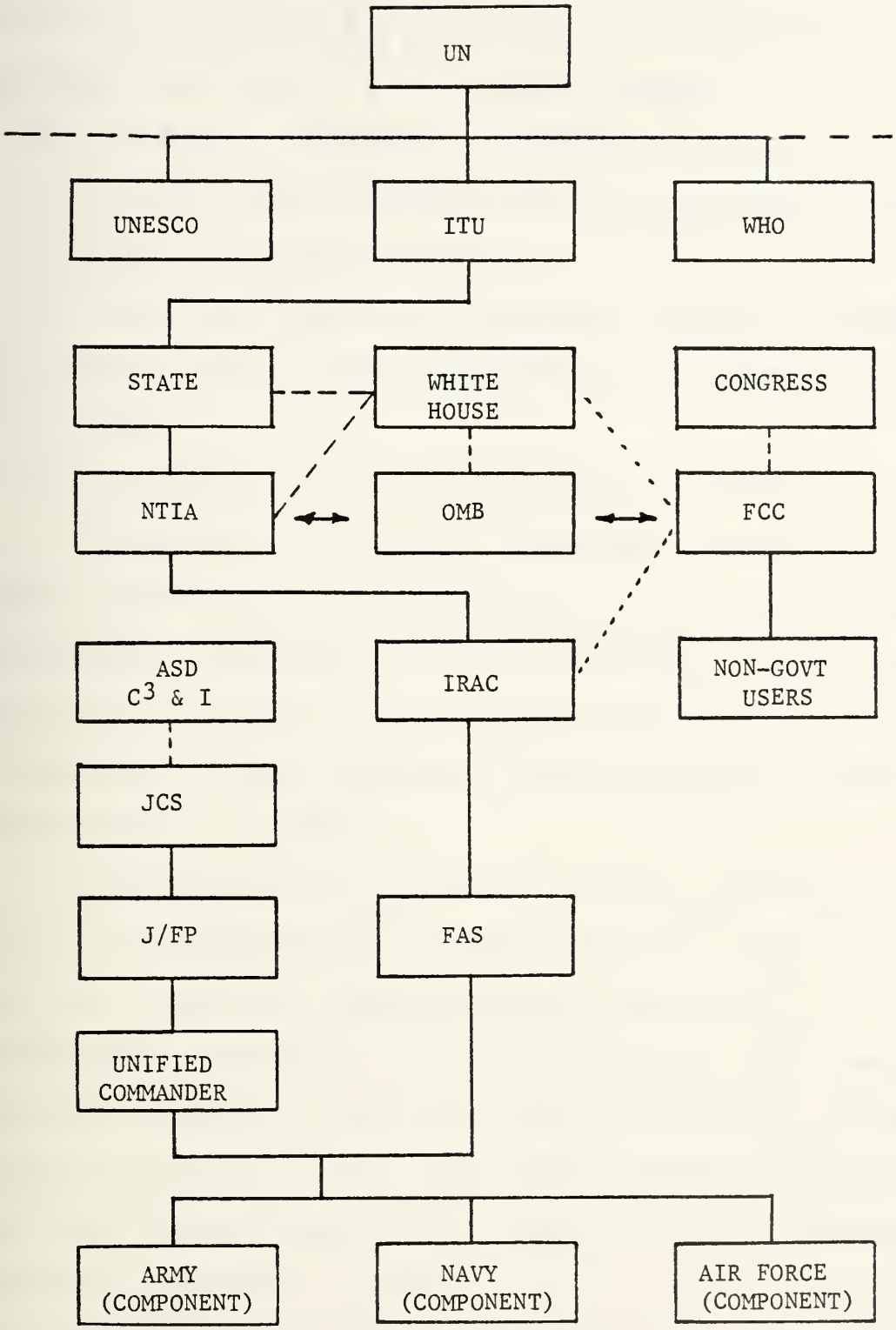
The next subsections will discuss the role of the four major frequency management groups within the Federal Government.

1. The Executive, Legislative, and Judicial Branches

The Executive and Legislative Branches of the Government influence the management of the radio frequency spectrum through the formulation and promulgation of policies and regulations governing the use of radio frequencies. For example, the Congress gives the President the authority to assign radio frequencies to Federal Government Radio Stations through the Communications Act of 1934 (Title 47, U.S. Code, beginning with Section 151). The Carter Administration has subsequently delegated this authority to the Administrator, National Telecommunications and Information Administration (NTIA) located within the Commerce Department (the functions relating to the assignment of frequencies to radio stations belonging to and operated by the United States were first delegated to the Secretary of Commerce by Reorganization Plan No. 1 of 1977 and Executive Order 12046 of 26 March, 1978. These functions were subsequently delegated to the Assistant Secretary of Commerce--Administrator NTIA--by Department of Commerce

Organization Order 10-10 of 9 May, 1978). The Communications Act of 1934 also established the Federal Communications Commission (FCC) and made it responsible for the management of the spectrum used by private citizens, local government, and state governments. This action created a parallel radio frequency management hierarchy in the United States as shown in Figure 5. This figure shows U.S. government users falling under the administrative control of the National Telecommunications and Information Administration (NTIA) and the Interdepartment Radio Advisory Committee (IRAC). Commercial and private users of the spectrum fall under the regulatory control of the Federal Communications Commission (FCC). In recognition of this parallel or dual jurisdiction over the radio frequency spectrum, the Federal Government and the FCC have divided the spectrum into three National categories of bands: exclusive Federal Government usage bands, exclusive non-Federal Government bands, and bands shared by the Federal Government and non-Federal Government users. The NTIA administers the Federal Government band while the FCC administers the non-Federal Government band. The shared band is administered through cooperation between the FCC and the IRAC.

The President maintains influence over both the NTIA and the FCC by his power of appointment of the Administrator, NTIA and the FCC Commissioners (Commissioners are appointed for seven year terms). The President can appoint up to four Commissioners from one political party. This provides some



United States
Frequency Management Hierarchy
Figure 5

Presidential influence over the seven-man Commission. Congress exercises control over the FCC through:

1) the House Committee on Interstate Commerce and Foreign Commerce through the Subcommittee on Oversight and Investigations;
2) the House Committee on Commerce, Science, Transportation through the Subcommittee on Communications; and,
3) the Senate Committee on Government Affairs.

Although the FCC is an independent agency, it is directly accountable to the Congress of the United States.[50] Congressional influence and accountability is in the form of oversight activities, passage of laws, the budget, and approval of Presidential appointments as the Administrator, NTIA and the Chairman of the FCC.

The Congress and President further influence the management of telecommunications through both formal and informal bargaining around the National Budget and through the Office of Management and Budget, i.e., the procurement of communications-electronics equipment and systems for the Federal Government and the Budget for the FCC. The United States Government consumes approximately forty-seven percent of the communications-electronics industry's output.[51] This level of consumption is a very powerful influence. The President also provides guidance to:

1) The Secretary of State in his role of conducting international negotiations concerning the radio

frequency spectrum; and,

2) the Joint Chiefs of Staff (JCS) in his role as Commander in Chief of the Armed Forces.

Finally, the Judicial Branch may review and decide on the Constitutionality or legality of all Presidential (NTIA) and Congressional (FCC) decisions and policies. Further, Judiciary may act as judge in disputes between the various agencies of the Federal Government.

2. Department of State

The formal role of the Department of State in telecommunications consists of:

1) preparation for international conferences including,
   a) selection of delegates for conferences, and
   b) formulation of negotiating positions;
2) participation on the U.S. International Radio Consultative Committee of the ITU;
3) representing the United States on the ITU Administrative Council;
4) making recommendations concerning the ratification of treaties; and,
5) representing the United States in bilateral arrangements or negotiations.

In essence, the role of the State Department is to act as the official negotiator in the international forum. Although this may seem to be a very limited role in frequency management, it is crucial because this is the manner in which the United States interjects and projects its telecommunications

goals internationally and determines the extent of U.S. participation in international telecommunications trade.

3. Department of Commerce, National Telecommunications & Information Administration

The third group in the national frequency management hierarchy is the National Telecommunications and Information Administration. Figure 5 shows the relative position of the NTIA within the hierarchy. This figure represents the author's view of the hierarchy and is the result of the research for this thesis which included interviews with various personnel within some of the agencies shown in the hierarchy. Figure 5 shows a more detailed picture of the frequency management hierarchy shown in Figure 1. The connections between the International Telecommunications Union (ITU), the Department of State (State), and the Department of Commerce-NTIA (NTIA) are indicate of frequency management information flow as in Figure 1. The dashed line between the Assistant Secretary of Defense for Communications, Command, Control, & Intelligence (ASD C^3 & I) and the Joint Chiefs of Staff represents a flow of guidance and policy for the use of the radio frequency spectrum. The dotted lines between the White House, Interdepartment Radio Advisory Committee (FCC) represent a mutual exchange of views and efforts toward mutual cooperation in management of the radio frequency spectrum. The arrows between the Office of Management and Budget (OMB), NTIA, and the FCC are representative of OMB's role as an arbiter of disputes in

frequency allocation or assignment between NTIA and the FCC. The connections below the IRAC, U.S. Military Communications Board-Joint Frequency Panel (USMCEB-J/FP), and Unified Commander are indicative of radio frequency allocations and assignment actions. They represent lines of formal control of the spectrum.

The NTIA was formed by the Carter Administration to replace the Office of Telecommunications Policy (OTP), which was part of the Executive Branch, and the Office of Telecommunications, Department of Commerce.

The purposes of the NTIA can be summarized as follows:

1) to provide expert analysis in telecommunications policy and policy research;
2) to promote telecommunications technology via,
   a) research and development,
   b) being a national clearinghouse for technological information,
   c) assisting in designing communications systems serving the goals of other Governmental units; and,
3) to manage and allocate the Federal Government's portion of the radio frequency spectrum.[52]

This last item specifically includes,

> Assign frequencies to, and amend, modify, and revoke frequency assignments for radio stations belonging to and operated by the United States, make frequency spectrum assignment allocation and use, and provide the various departments and agencies with guidance to assure that their conduct of telecommunications activities is consistent with these policies. . .

> Develop in cooperation with the Federal Communications Commission, a comprehensive long-range plan for improved management of all electromagnetic spectrum resources, including jointly determining the National Table of Frequency Allocations.[53]

Essentially the NTIA provides support for the telecommunications activities of other Government agencies in the form of design and engineering support. Further, it oversees the implementation of national telecommunications policy.

The frequency management functions of the NTIA are actually performed by the Associate Administrator, Office of Federal Systems and Spectrum Management. Thus the President's responsibility for the assignment of radio frequencies to Federal Government owned and operated radio stations is delegated to a third eschelon unit within the Federal hierarchy. This point will be important in the discussion of the centralization-decentralization of National telecommunications policy.

The Office of Federal Systems and Spectrum Management also provides the staff support for the Interdepartment Radio Advisory Committee (IRAC).

a. Interdepartment Radio Advisory Committee

The Interdepartment Radio Advisory Committee was established on 22 June 1922, as the Interdepartment Advisory Committee on Government Radio Broadcasting. In 1923, its name was changed to its present name. Initially, the IRAC was not the result of Legislative or Presidential dictates. It was formed spontaneously by interested Government agencies because very early in the growth of Government owned and operated radio stations it became apparent that cooperation would enhance

interference-free functioning between Government radio stations. The IRAC advised and reported to the President on frequency assignments to Government radio stations without official sanctioning until 8 April 1927. On that date President Calvin Coolidge sent a letter to Secretary of Commerce Herbert Hoover affirming the actions of the IRAC in assuming responsibility on behalf of the President.[54] Since then the IRAC has acted as a clearinghouse in the coordination and assignment of frequencies to radio stations of the Federal Government.

The mission of the IRAC is to formulate objectives, policies, plans, and actions in connection with the management and use of the radio frequency spectrum in the National interest. The Committee coordinates the assignment of frequencies for government radio station use within the United States and Possessions among various government agencies. The FCC provides a liaison representative to the IRAC to ensure coordination between the Government and non-Government portions of the spectrum and especially in the shared portions of the spectrum.

The IRAC has four major subcommittees and various ad hoc working groups. The four major subcommittees are the Spectrum Planning Subcommittee (SPS), the Frequency Allocation Subcommittee (FAS), the Technical Subcommittee (TSC), and the International Notification Group (ING).

The role of the Spectrum Planning Subcommittee is planning for the apportionment of the radio frequency spectrum in support of existing and anticipated services. The SPS also concerns itself with the apportionment of the spectrum between

Government and non-Government users. Specifically, the SPS is tasked by the IRAC to consider

> Current and planned National and International frequency uses, and the optimum placement of radio services with a view to the most effective use of spectrum in the overall National interest. . .
>
> . . . Specific proposals for expansion, reduction, or other changes in the allocated frequency bands; and the International aspects of changes recommended to the IRAC.[55]

The SPS is, therefore, predominantly the planning and policy formulation body for the whole IRAC and, consequently, for the Federal Government as a whole.

The role of the Frequency Allocation Subcommittee (FAS) is to carry out the assignment of frequencies to Government users. The FAS has two subcommittees: the Aeronautical Assignment Group (AAG) and the Military Assignment Group (MAG). The AAG handles assignment and coordination of frequencies primarily concerned with the aeronautical mobile and aeronautical radionavigation services. The AAG is chaired by the Federal Aviation Administration (FAA). The MAG handles assignmen and coordination of frequencies of primary concern to the military services. Matters which are not amenabale to solution by the MAG or AAG membership are submitted to the FAS for resolution.

Prior to the use of any communications-electronics system within the United States and Possessions, U.S. Government departments and agencies are required to obtain authorization for its use from the FAS. This authorization is for specific channel use and contains any applicable constraints.

For the Navy this authorization is obtained via the Navy Electromagnetic Spectrum Center (NAVEMSCEN), the Navy's representative on the IRAC. See Chapter Three for NAVEMSCEN's role.

Rarely does the MAG or AAG meet in formal session. Virtually all coordination is done on an informal basis, that is, without formal meetings or agendas. This is possible because discrete assignments have been made to each of the Armed Forces within the bands of the spectrum designated for Government use. Thus, little coordination is required unless one Service wants to use another's assignment. If the group concurs in an assignment, formal approval is forthcoming from the Frequency Assignment Subcommittee.

The Technical Subcommittee (TSC) assists the Administrator, National Telecommunications & Information Administration, in handling problems concerning frequency allocations for new communications-electronics systems. The TSC's major functions include evaluating the technical bases for spectrum management, issuing technical reports concerning new and existing techniques for the utilization of the spectrum, and recommending and developing new equipment standards. The TSC must be acutely aware of International Telecommunication Union recommended standards. A major function of the TSC is, therefore, to ensure system compatibility and interconnectivity.

The last major subcommittee of the IRAC is the International Notification Group (ING). The subcommittee prepares responses to ITU questionnaires and handles correspondence related to the registration of United States frequency assignments

with the International Frequency Registration Board (IFRB) of the International Telecommunication Union.

4. Department of Defense

The Department of Defense (DoD) is a separate entity in the National spectrum management hierarchy. Considerations pertaining to the use of the radio frequency spectrum may involve the Office of the Secretary of Defense (OSD), Director of Defense Research and Engineering (DDR&E), Assistant Secretary of Defense for Communications, Command, Control, and Intelligence (ASD C^3 &I), etc. The focus of frequency management in DoD is the staffs of the military departments (MILDEPS) who respond through the joint staff or intradepartmental chain in accordance with the matter under consideration. Spectrum management authority may flow through multi-lateral Government Channels (IRAC) for frequency management matters within the United States & Possessions or through strictly military channels (U.S. Military Communications-Electronics Board--USMCEB) for all other military matters worldwide. For example, the coordination of a single Department of the Navy frequency request may, depending on geographic area, go through both chains for approval. It is noteworthy, therefore, that the Department of Defense, per se, does not have an IRAC representative even though it controls the largest telecommunications network in the Federal Government, the Defense Communications System (DCS). Figures provided by the NTIA show that as of 1 June 1979, the Armed Forces controlled forty-two percent of the frequencies assigned to the Federal Government.[56]

Because the DCS consists of the combined assets of the individual Service's communications systems, the DCS is the largest single user of radio frequencies in the United States. The Director of the Defense Communications Agency, as the senior manager of the DCS, gets frequency support for the DCS through the individual Armed Services, whose combined assets form the DCS.

Although there are representatives from each of the Armed Services on the Interdepartment Radio Advisory Committee, no single person acts on behalf of the Department of Defense as a department.[57] Collectively, the Armed Service representatives represent the Department of Defense's interests, but are responsible only to their parent Service in their actions. Informed sources in the IRAC say that the Service representatives usually present a united front when opposing other Government representatives concerning these items of mutual interest to the Services.

The preceeding sections have introduced the major players in the Federal frequency management hierarchy. However, the author was unable to ascertain exactly how some of the various players actually interacted to manage the radio frequency spectrum for the Federal Government. The exact mechanism by which the IRAC, for example, conducts its business is not known to the author as the IRAC publishes no records of its meetings.

Drawing on what information is available, the following section will discuss how these players interact. The discussion

of how the military interacts with the IRAC and within itself will be discussed in the next chapter.

B. FREQUENCY COORDINATION AT THE NATIONAL LEVEL

Before beginning a discussion of frequency coordination at any level it is important to define this term. The author has found, in reviewing available literature, that this term has varying definitions depending on the background of the author. Some authors use it in various ways without specifying the subtleties in its use. For the purpose of this thesis the author defines frequency coordination as a process of cooperation, negotiation, and bargaining among radio frequency spectrum users or potential users by which users achieve freedom from unacceptable interference.

The military's definition of coordination is more succinct, but not as explicative of the actual mechanism of coordination. The military definition of coordination is the process of affecting arrangements and technical liaison for the purpose of minimizing electromagnetic interference through cooperative use of the radio frequency spectrum.[58]

The process of frequency coordination begins with the assignment of a mission to a Government agency by the President or the Congress. For example, part of the Navy's and Marine Corps' mission or function is to organize, train, and equip Navy and Marine Corps forces for the conduct of prompt and sustained combat operations at sea.[59] Then program planning budgets to carry out the assigned mission are submitted by

program managers to the agency head, Office of Management and Budget, the President, and the Congress.

Upon approval and appropriation of funds, the Government agency analyzes its mission to determine the communications-electronics support requirements. For example, what must be done to maintain command and control over the forces at sea and how will these forces be able to locate the enemy? Reasonably, radiolocation (radar) systems and radio communication systems would be useful in carrying out the Navy's mission. Each Government agency is free to decide, in the light of policies, rules, regulations, frequency allocations, and availability of frequencies, whether, and how much communications-electronics support is needed to carry out its mission. The agency makes the necessary technical studies, selects possible frequencies, coordinates the selections with other agencies, and files an application for frequency assignment with the Executive Secretary of the Interdepartment Radio Advisory Committee (IRAC).

If it becomes apparent that frequency support is not available without impacting existing operations, the IRAC is consulted. When new types of communications-electronics equipments are required, an electromagnetic compatibility analysis is conducted to determine whether there will be an adverse impact on existing operations. Both Government agencies and the Armed Services are required to obtain frequency allocation/assignments before funds may be obligated to equipment development or procurement.[60]

In cases where spectrum support is possible without electromagnetic compatability analysis, the agency frequency manager consults frequency assignment/usage records, conducts the necessary technical studies, and coordinates the frequency selection with the other agencies at the local level. The agency frequency manager then files an application with the Executive Secretary of the IRAC. If the proposal is not technically compatible with existing authorizations, adjustments are made or the process is repeated until a soluion is found.

To ensure Government/non-Government coordination the FCC Liaison Representative to the IRAC submits memoranda requests for coordination on non-Government use of frequencies in shared frequency bands, and in other bands when he considers mutual interference with Government operations may occur. This procedure would appear to ensure coordination and cooperation between the two sectors; however, an informed Government user indicates that Government users do not always record used frequencies inferring an effort to prevent the tracing of sources of interference with non-Government users. One comment was made that, ". . . if we don't record the (frequency) assignment, they (the FCC) won't know it's us causing the interference."

The IRAC Secretariat screens the applications for accuracy, completeness, and compliance with procedure. Applications that have been screened and accepted are placed on the Frequency Assignment Subcommittee (FAS) agenda.

Each month the FAS/FCC Liaison considers pending items and takes mutually agreed actions for assignment actions within policy guidance. Applications are referred to the full IRAC/FCC for resolution when policy guidance is needed, agreement cannot be reached by the FAS/FCC Liaison, or an agency requests it. Matters which then cannot be resolved are referred to the Office of Management and Budget (OMB) for resolution.

Once a frequency allocation or assignment is approved, the IRAC Secretariat updates the Government Master File from which it prints the list of Frequency Assignments to Government Radio Stations. The department or agency representative, i.e., the Navy Electromagnetic Spectrum Center (NAVEMSCEN) for the Navy, then authorizes the use of the frequency by the department's requester.

This section has dealth with the coordination and assignment of frequencies at the National Level. The author has presented an overview of how the Federal Government manages frequencies used by the various agencies and departments of the Government.

The final section deals with the issue of telecommunications policy and its centralization-decentralization.

C. TELECOMMUNICATION POLICY

Telecommunications policies, such as adherence to the International Telecommunications Union frequency allocation plan, are made by the Congress, the Courts, the President, and the NTIA's Administrator for the agencies and establishments of the Federal Government. The Federal Communications

Commission makes policy in the private sector. Policy is made:

1) through treaties to which the United States adheres;
2) through executive agreements between departments;
3) by executive departments and agencies in the discharge of their telecommunication responsibilities; and,
4) by custom and precedent.

These policies may be separated into three categories: National Telecommunications Policy (for International coordination); Telecommunications Policy applying to the Federal Government (domestic policies); and, Federal Communications Commission Telecommunications Policy.

For the purpose of this thesis, policy is defined as a definite method of action chosen from alternative courses of action by a government in the light of given conditions to guide and determine present and future decisions.[61] Stated policy is an essential means of managing uncertainty. Policy expresses the intention of the policy-maker to follow certain prescribed measures in order to achieve an end. If the most effective means to achieve the desired end were clear, common sense could constitute policy. Policy-making reduces the uncertainties that must be considered by those having the responsibility for planning, decision-making, or both. Conflicts between values or relative effectiveness of alternative courses of action are examples of such uncertainties.

Within any government, stated policy helps to ensure that separate decisions support one another in sustaining progress

toward consensus goals. The more decentralized the decision-making in government, the more essential policy-making becomes. As stated above, each individual department and agency is responsible for deciding the extent of its communications-electronics support requirements. Policy, therefore, becomes essential in this instance. For example, it is is the policy of the Federal Government that common-user telecommunications circuits are to be utilized wherever possible in lieu of establishing new dedicated circuits, then agencies will make every effort to identify such circuits before trying to establish dedicated circuits. For extragovernmental organizations, policy reduces the uncertainty of governmental action.

An Aspen Institute for Humanistic Studies report states:

> The definition of the Federal government's role in the field of telecommunications is itself a policy issue that is central to the design of the government's policy making system; for the federal role in telecommunications must be consistent with its responsibilities in defense, international trade, and the maintenance of United States scientific and technological leadership, and the procurement of telecommunications systems and services for the government's own use. Federal roles in health, education, welfare, and transportation also have implications for telecommunications policy.[62]

The author interprets this to mean that Federal telecommunications policy can either help people obtain or deprive them of benefits resulting from the more efficient operation of Federal agencies serving the public. For example, the redirecting of funds saved as a result of substituting tele-conferencing systems for expensive transportation to conferences.

In general, the telecommunications policy which does exist has evolved in response to specific issues on an ad hoc

piecemeal basis rather than on a conscious, systematic, or sophisticated basis.[63] The author believes the piecemeal nature of present telecommunications policy is not conductive to optimum performance of telecommunications activities and requirements of the Federal Government.

Because telecommunications has been historically viewed by users in a mission-support role, no centralized authority for managing the spectrum exists. Responsibility for communications-electronics system specifications is dispersed among a myriad of mission-oriented agencies. The procurement of telecommunications systems is viewed as a mission-support function without consideration of an overall telecommunications policy. It should be noted that this practice of decentralized system specifications is itself a policy. The purchasing power of the Federal Government in the acquisition cycle helps to drive telecommunications technology, but the Government's R & D and acquistion efforts have not been coordinated to ensure that the benefits of telecommunications technology are realized. The acquisition cycle serves an important indirect function that is not always recognized; it provides a unique opportunity to develop and introduce innovative operational and support concepts.

Senator Harrison Schmitt, in prepared remarks for Congress said,

> National telecommunications policies must be closely coordinated with other domestic and international policies. . . I am afraid that once again the Administration has missed the fact that all international policy must be coordinated to be successful.[64]

Although Senator Schmitt was speaking specifically of the United States preparations for the General World Administrative Radio Conference-1979 (GWARC-79), his remarks are applicable to frequency management. He further argues that the United States is jeopardizing its multi-billion dollar investment in communications-electronics systems because no firm policies are being formulated concerning frequency allocations. In response to a personal letter from the author concerning national telecommunications policy, Senator Schmitt did not specifically address the issue of policy. A telephone interview with a National Telecommunications & Information Administration official may have been an indicator of why Senator Schmitt was unable to reply. The official stated that no conscious policy or long-range plan currently exists, but there is one in the formulation stages.

The author believes the issue is whether one organization should act as the central policy-making body for communications-electronics systems development and frequency management policy, or whether the United States should continue its current policy-making practices. A second issue is, if centralization is to be adopted, at what level in the Government hierarchy should this centralized organization exist? Should telecommunication policy be established by a third eschelon official as it is now, i.e., the Administrator of the National Telecommunications & Information Administration, or should it be vested in the highest echelon, the Executive Office of the President? The disbanding of the Office of Telecommunications Policy is

seen by the proponents of centralization as the Carter Administration's view of the relative importance of telecommunications policy; it has been relegated to a lower level of importance. Although a small telecommunications staff will be maintained in the Executive Office as a part of the Domestic Policy Staff, its qualifications are unknown. However, as a result of its small size the author believes that it will lack the ability to be the focus for coordinating telecommunications policy.

This alleged lowering of status is inappropriate in view of the opening lines of a publication entitled The Radio Frequency Spectrum, United States Use and Management which says,

> The United States is vitally dependent upon the use of the Radio Spectrum to carry out national policies and achieve goals. Use of the spectrum is vital to the security and welfare of the Nation and to the conduct of its foreign affairs. This use exerts a powerful influence on our everyday lives, in countless ways, annually contributing significantly to the Nation's growth and economy.[65]

If the use of the radio frequency spectrum is so vital to U.S. interests, it appears inconsistent in the author's view to relegate telecommunications policy to third or fourth echelon officials. The author believes that without coordinated policy-making and management the Nation will be faced with having communication-electronic systems that face overly restrictive standards, and the denial of telecommunications services because of networking problems. The continuing absence of long-range planning reflects the Federal Government's historical perspective of telecommunications as exclusively

a mission-support function rather than a crucial area of public policy on its own.[66]

As early as the Truman administration a recommendation was made for the:

> Immediate establishment in the Executive Office of the President. . . a telecommunications advisory board. . . to advise and assist the President in the discharge of his responsibilities in the telecommunications field. Its task would include formulating and recommending broad national policies in this field giving advice and assistance in the formulation of policies in positions for international telecommunications negotiations.[67]

Further, in a dissertation on Frequency Assignment Administration Control, Donald R. MacQuivey stated,

> . . . the most desirable location for the control of the optimum frequency management system should be in the Executive Office of the President because the prestige of that Office and its experience in the developing of rules, settlements of inter-agency disputes and its close relationship to decision making of nationwide scope, concern and importance.[68]

In 1967, a Lyndon Johnson appointed task force concluded that the Federal Government required,

> . . . a long-range planning policy-formulating and coordinating and mission-support capability which can serve to integrate the various roles in which the Executive Branch is presently engaged.[69]

In 1969, the General Accounting Office reported,

> . . . that a realignment of existing NSC structure and organizational arrangements should be undertaken. As a first and essential step, an organization or entity at the highest level of the Executive Branch of government, free of any conflicting roles, should be put in charge of the government's telecommunications activities. . . and serve as the government's focal point for telecommunications policy and planning. . .[70]

Decentralized policy-making leaves us with a confused, and often contradictory, patchwork of policies. This patchwork of policies is especially costly on the domestic scene;

each governmental agency is free to determine its own communications-electronics systems requirements. This generates a plethora of communications-electronics systems which duplicate existing systems, dedicated systems where existing common-user systems are underutilized, and, therefore, are more costly, and lack interconnectivity with other systems.

Informed opponents of centralization view this centralization policy as dangerous. A centralized body may suffer from tunnel-vision, refusing to accept ideas and alternatives from sources outside the body. The acceptance of fresh ideas from outside sources could provide critical perspectives on current policies and suggest directions for new policy or changes in policy. The author believes a centralized body could more successfully coordinate telecommunications policy with other United States policies. For example, a policy must be coordinated for the United States privately owned portion of INTELSAT, for the U.S. Military's participation in NATO telecommunications, and for international-transoceanic cable connections.

Further, opponents of centralization see centralization efforts as destroying the autonomy of the Governmental departments and agencies in deicision-making by saddling them with unnecessary constraints. Because telecommunications are traditionally viewed as purely mission-support functions, proponents of decentralization insist that only the individual department or agency can adequately determine communications-electronics for conducting their assigned mission. Outside interference, such as that from a centralized telecommunication

policy-making body would only serve to inhibit them from choosing the optimum communications-electronics system in terms of money, manpower, or other resources. Further, because each department or agency views its mission requirements as unique, only a dedicated communications-electronics system can adequately meet these needs; therefore, forcing them to become part of a common-user circuit would, in some way, be forcing them to sub-optimize their decision-making or challenge their autonomy in carrying out their mission.

D. CONCLUSION

Structurally, decision-making for telecommunications is decentralized within the Federal hierarchy. Each organizational unit within the hierarchy is free to determine whether and how much telecommunications support is needed to carry out its assigned mission. This includes determining whether the use of telecommunications, hence, frequency support is required. Further, each unit is responsible for conducting the necessary technical studies and inter-organizational coordination. The author feels that this carte blanche approach allows a unit to justify virtually any telecommunications support requirements without the scrutiny of higher authority. If this authority is a disinterested party, the disinterested party may be able to better assess alternative telecommunications support in light of existing common-user circuits thus reducing the number of high-cost, dedicated services which would otherwise proliferate. Each Governmental unit should be aware of communications-electronics support policies, rules,

and regulations. However, freedom in interpretation of policies, and regulations can be used to justify communications-electronics decisions made by the unit. A disinterested party should be able to more equitably implement policy, rules, and regulations through consistent interpretation of stated policy.

The role of the Federal Government in health, education, welfare, transportation, national defense, etc., has implications for telecommunications.[71] The contributions of telecommunications to the society at large lie principally in improvements in the effectiveness and the efficiency of the agencies that use telecommunications. Concomitantly, there are federal decisions made about the depth and magnitude of governmental interventions into the telecommunications market--whether in the form of restrictive regulations or incentives to promote the industry--in the interst of telecommunications goods and services consumers.

In a study made for the Commerce Department, the Aspen Institue for Humanistic Studies stated that because communications-electronics related decision-making is decentralized within the Government hierarchy, it is essential that this decision-making be coordinated to achieve stated National telecommunications goals. This implies that such goals do exist. One method of coordinating diffuse decision-making is the implementation of well-conceived policy. This policy coordination is especially important where the subunits of an organization are highly interdependent. The author believes that because of the way in which decisions made by one agency

can affect other agencies that the agencies within the Federal hierarchy are interdependent. For example, Department of Transportation plans for federal highway systems are dependent, in part, on demographic data supplied by the Census Bureau. A Census Bureau decision to collect data in such a way that population trends are not revealed could adversely affect Transportation Department decisions concerning where to locate new highways. Further research is necessary to determine the degree of interdependency.

In researching this thesis the author was unable to find stated National Telecommunications Policy. Telephone conversations with National Telecommunications & Information Administration officials indicated that there is indeed no long range plan yet established and that policy was contained in the NTIA's Manual of Regulations and Procedures for Federal Radio Frequency Management.[72] It should be noted that the overwhelming majority of the policy set forth in the Manual contains technical standards. For example, a Five-Year Review Procedure for radio frequency assignments is contained on one-half of one page and is stated in very broad terms while bandwidth limits, emmission standards, etc., cover many pages. Other available non-technical policy statements are of the motherhood-and-apple-pie ilk. Further work is needed in the area of non-technical telecommunications policy formulation.

The problem may lie with the dynamic nature of electronics technology; the bureaucratic machinery just cannot keep abreast of the new technologies that are coming to the fore. Indicative

of the nature of the rapid change in electronics is the decline in new electronics patents. Technology is moving so fast that better devices are being developed while patent applications are being processed, negating the value of the patent. The problem of policy-making is manifold. For example, the difficulty in getting a group of communications-electronics experts to agree on the state of the art in electronics and where we want to go in the future is immense. Actually, the question might be better stated as where we should go in the future and what sort of societal goals should guide technology. The social, economic, and political impacts of such a question make it most difficult to answer, and represents another area for future research. Further, for government to be effective in handling the needs of its people, it is necessary to ultimately coordinate the implementation of all National Policies so that they are mutually supportive. Telecommunications can be viewed as the link that joins the various agencies of the Federal Government implying a degree of inter-organizational dependence; the greater the degree of this interdependence, the greater the need for coordination of telecommunications policy. An area of needed study is, therefore, the determination of the degree of interdependence of the various departments, agencies, and organizations of the Federal hierarchy. The interdependence may vary depending upon the type of decision to be made and the degree of immediacy involved. One measure of interdependence that may be used is the effect on the budget dollars available to each department/agency because of decisions

that they make. For example, in the previously cited Transportation-Census example, if the Census Bureau decides not to provide data to the Transportation Department, Transportation may have to expend funds for demographic research or face the prospect of expending funds on unneeded highways.

If a centralized telecommunications policy-making office is to be formed, where would that office be located to influence the implementation of policy?

One way to achieve the necessary influence to promote the implementation of policy is to place the centralized policy-making organization in the White House. Policy statements bearing the signature of the Nation's Chief Executive would presumably carry more weight than those signed by a third-echelon official such as the Assistant Secretary of Commerce, Director, National Telecommunications & Information Administration. It is true that the President can exert coercive control over telecommunications via the Office of Management and Budget's control of the National Budget and the OMB's role as the arbiter of conflicts between the National Telecommunications & Information Administration and the Federal Communications Commission, but this is a back-door approach to the problem. However, Richard Neustadt of the White House Domestic Policy Staff has stated,

> It is tempting to think you can improve policy by elevating its level; sound management demands otherwise.[73]

He suggests that the Office of Telecommunications Policy did not fit into the Executive Office as it had no connection with the day-to-day work of the President, its location in

the White House kept it so small that two-thirds of its work was sub-contracted to the Commerce Department's Office of Telecommunications, and the Nixon Administration ". . .poisoned its image and alienated its constituency. . ."[74]

Dr. Clay T. Whitehead, former Director of the Office of Telecommunications Policy, remarked,

> There has to be some degree of centralized planning and management of communications in the Federal Government. . we must centralize enough to promote competent aggressive technical and management leadership. . . coordination must be accomplished without unduly watering down the responsibility of the basic operating channels. . . What is needed in the government is a sound planning process--one which constantly recognizes new technology and new needs, and which identifies basic long-range and short-range choices that have to be made.[75]

This need for planning, management, and policy-making applies not only to communications-electronics technology, but to all other National Policies as well. It is difficult for the author to imagine any level of Government better equipped than the Executive Office of the President for coordinating national policies. Whether the policy to be coordinated is made by the Chief Executive or the United States Congress, a central office from which to conduct coordination is needed.

In the area of Government operations, the Interdepartment Radio Advisory Committee has come under fire. A criticism of the Interdepartment Radio Advisory Committee comes from the contrast between the Federal Communication Commission's open-door mandate when supervising the spectrum used by non-Government users and the secretive style of the Interdeparment

Radio Advisory Committee. The Federal Communication Commission's practice of public decision-making preceeded by ample notice, open hearings, confrontation, cross-examination, right to counsel, recorded decisions, and impartial tribunals is in sharp contrast to the Interdepartment Radio Advisory Committee's closed hearings, lack of published rules or opinions, and dirth of public or industry participation. This results in a bias against non-Government users in two ways:

1) the absence of formal screening eases the obtaining of the assignment of frequencies for Government users; and,
2) the Federal Communications Commission's willingness to accede to Interdepartment Radio Advisory Committee requests for frequencies otherwise available for civilian use, especially in view of the difficulty in challenging the expertise of the Government in National Security determinations.[76]

A suggested method for overcoming this problem is the pooling of all frequencies and the assignment from this pool to any Government or non-Government users based in some way on a free-market determination of the opportunity costs, etc., of the frequency assignment. Richard Neustadt has suggested that this be done when he said,

> It would make sense to unify public and private frequency management and improve coordination with State (Department of State) and others.[77]

This would involve extensive work in pricing of the spectrum for the free-market, a subject for further work.

Another criticism of the Interdepartment Radio Advisory Committee-Federal Communications Commission interface is the lack of a comparative evaluation of Government and non-Government requests for conflicting frequency assignments. This results in favoritism of the Government's request for frequency assignments even in view of a lack of rigorous evaluation of the Federal Government's request for assignment by the Interdepartment Radio Advisory Committee and a lack of evidence that Federal interests are necessarily representative of the public's interest.

Although policy-making is not the only method of coordinating the Federal Government's use of the radio frequency spectrum, the author believes that it is a first step in providing a framework around which to build the process of coordination. It is a way of reducing uncertainty about what is acceptable and how the authority overseeing implementation of policy will react to deviations from policy. Monitoring and control systems are important parts of coordinating, but are beyond the scope of this thesis.

The next chapter deals with military frequency management procedures.

IV. FREQUENCY MANAGEMENT: THE MILITARY PERSPECTIVE

This chapter explores the third level in the author's suggested hierarchy, the National Level: Military. The process of frequency management-assignment will be used to introduce the major players in military frequency management. The process of frequency assignment will be reviewed in two segments. First, frequency assignment in the United States & Possessions and second, frequency assignment outside the United States & Possessions. Frequency assignment flow charts will be used to review the assignment process. The attributes of the major players in the frequency management hierarchy which directly impinge upon the Navy are summarized in Table 1. The role of the National Telecommunications & Information Administration was discussed in the preceding chapter and is not recapped in Table 1. However, because of the Interdepartment Radio Advisory Committee's role in frequency management, its attributes are recapped in Table 1.

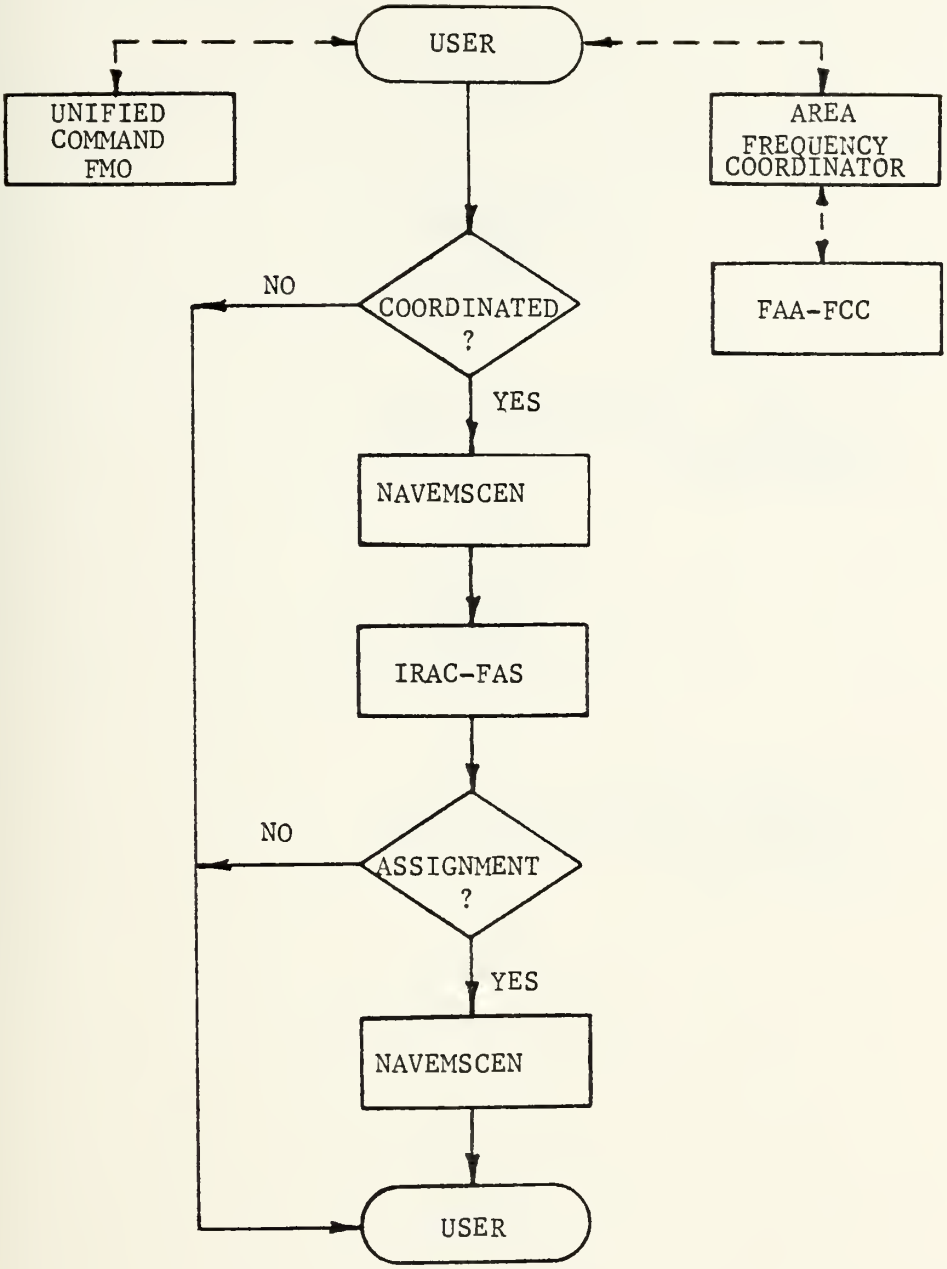
A. FREQUENCY ASSIGNMENT: DUAL ROUTES

Figure 5 shows a complex frequency management hierarchy. It represents the primary view of the frequency management hierarchy held by the author. This presentation of the hierarchy is the result of personal and telephone contact with officials in the National Telecommunications & Information Administration, the Navy Electromagnetic Spectrum Center, the Commander in Chief Pacific's Communications-Electronics Directorate, and official U.S. Government documents.

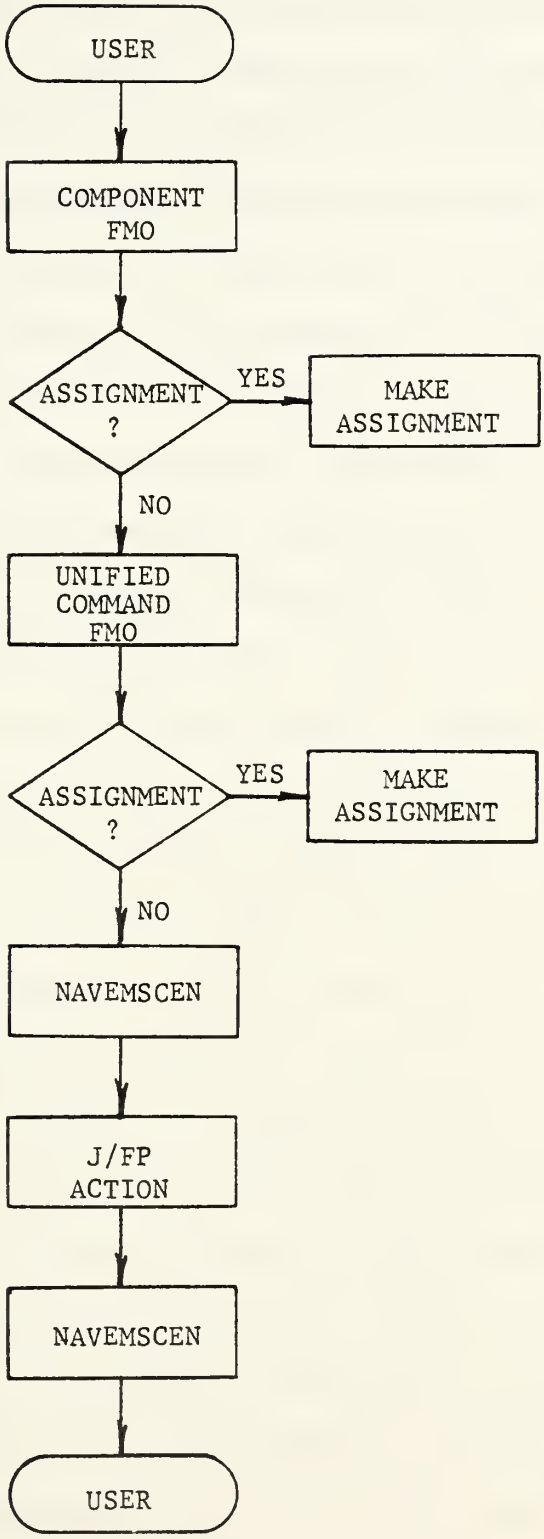
For the purpose of this discussion the left-hand portion of Figure 5 below the Assistant Secretary of Defense for Communications, Command, Control, and Intelligence (ASD C^3&I) and the Interdepartment Radio Advisory Committee (IRAC) is most important. For frequency assignment inside the United States & Possessions follows a path from the user (Army, Navy, Air Force) to the Frequency Assignment Subcommittee (FAS). Figure 6 gives the details of the frequency assignment process along this route. Figure 7 shows the route to be followed for frequency assignment outside the United States & Possessions. In Figure 5 this route is from the user through the unified commander to the Joint Frequency Panel (J/FP).

The author intends the connection between the Army-Navy-Air Force units and the FAS-J/FP through the unified commander to be indicative of the unified commander's limited ability to assign frequencies outside the United States & Possessions (to be discussed later). The direct connection between the Army-Navy-Air Force indicates that the unified commander remains outside the assignment chain inside the United States & Possessions. The labeling of the bottom-most blocks in Figure 5 is designed to indicate that outside the United States & Possessions frequency user-requesters are component commands of the unified command, while inside the United States and Possessions the block represents a user-requester not under the jurisdiction of a unified command.

The next section will discuss frequency assignment in the United States and Possessions.



Frequency Assignment
United States & Possessions
Figure 6



Frequency Assignment
Outside United States & Possessions
Figure 7

1. Frequency Assignment in the United States & Possessions

Figure 6 shows that the Navy user-requester of a frequency must coordinate his request with the area frequency coordinator. An area frequency coordinator is assigned in the vicinity of Research & Development testing activities, e.g., China Lake Naval Weapons Station, China Lake, California. Their main purpose is to protect the frequencies used by the test facility from interference by analyzing frequency assignment requests to verify electromagnetic compatibility with existing frequencies. Area frequency coordinators are usually assigned in areas where no unified commander exists. If a unified command does exist in the area, then the area frequency coordinator must coordinate with the unified commander's staff concerning frequency proposals for support of test facilities.[78] The area frequency coordinator also interacts with local representatives of the Federal Aviation Administration and the Federal Communications Commission to prevent harmful interference to or from frequencies currently authorized for use by either of these two agencies. The user-requester chooses his desired frequency in accordance with radio frequency propagation characteristics as shown in Figure 4 and the U.S. Government Table of Frequency Allocations. The U.S. Government Table of Frequency Allocations is one part of the National Table of Frequency Allocations. The National Table of Frequency Allocations is composed of the U.S. Government Table of Frequency Allocations and the Federal Commumications Commission Table of Frequency Allocations. The U.S. Government

Table of Frequency Allocations indicates the allocation of frequencies to telecommunications services used by the Federal Government in the United States & Possessions. The National Table of Frequency Allocations also indicates the degree of compliance with International Telecommunications Union frequency allocations.[79] International Telecommunication Union Radio Regulations permit individual nations to allocate frequencies to any desired telecommunication service for use in that nation. This is permitted only if use of frequencies so allocated does not interfere with users in other nations whose use is in compliance with International Telecommunication Union Radio Regulations.[80] For example, the United States, at present, conducts broadcast operations only in internationally designated broadcast bands, whereas LDC'S may use non-broadcast frequencies for broadcast causing interference.[81]

In addition to the area frequency coordinator, the Navy user must coordinate with the local unified commander's frequency management office. The purpose of this is inter-Service coordination in an effort to preclude mutual interference between military users. Navy users must also coordinate with the local Naval Communications Station or Communications Area Master Station to prevent interference with fleet communications.

The area frequency coordinator's comments/recommendations are submitted to the Frequency Assignment Subcommittee of the Interdepartment Radio Advisory Committee as a part of the actual frequency application.[82] The Frequency Assignment Subcommittee then makes an assignment decision based on the

information presented in the application, the area frequency coordinator's comments/recommendations, and any information presented by the Navy Electromagnetic Spectrum Center.

Two permanent groups of the Frequency Assignment Subcommittee's substructure which make many military assignments are the Aeronautical Assignment Group and the Military Assignment Group. Aeronautical and/or Military Assignment Group approval/disapproval of applications is tantamount to Frequency Assignment Subcommittee action.[83] However, any action lacking unanimity is referred to the Frequency Assignment Subcommittee for its action.[84] The Aeronautical and Military Assignment Groups were designed to conduct their business without the benefit of formal meetings.[85] Most coordination is done by telephone or memorandum. However, any member may request that a formal meeting be held.[86]

The voting procedure to be used in the Interdepartment Radio Advisory Committee and the Frequency Assignment Subcommittee is outlined in the Manual of Regulations & Procedures for Federal Radio Frequency Management published by the National Telecommunications & Information Administration. These procedures include 1) majority rule in voting, 2) the ability to file a minority opinion in the record of the committee in the case of questions lacking unanimity, and 3) the right to request that questions lacking in unanimity be referred to the National Telecommunications & Information Administration for action.[87]

Once a frequency has been asigned to a Navy user, the Navy Electromagnetic Spectrum Center acting on behalf of the Cheif of Naval Operations authorizes that frequency for use by the Navy requester.

2. Frequency Assignment Outside the United States & Possessions

Spectrum management takes on added complexity in areas outside the jurisdiction of the United States. The radio frequency spectrum is considered to be a natural resource within the boundaries of any country exercising its sovereignty; therefore, radio frequencies may be used only with the permission of that country. Any deviation from established agreements by military forces may adversely affect relations with the host nation.

Furthermore, the sovereign rights and needs of allied and friendly governments cannot be preempted in time of war or conflict. The sovereign's requirements for essential communications-electronics services must be protected, and this need for protection must be considered in contingency planning. It is true that some civilian requirements must yield in time of war or conflict, but basic requirements for coordination and the channels through which coordination is exercised do not materially change from peace to war.

Spectrum management in an overseas area is under the control of the highest command present. In all overseas commands involving large geographic areas and employing Army, Navy, and Air Force Units a unified command is established. Major Army, Navy, and Air Force headquarters in these areas

serve as component commands. In some cases a mission requires a force consisting of units from one service making it a specified command. An example of a unified command is Commander in Chief Pacific, while an example of a specified command is Commander in Chief Strategic Air Command.

If a unified command is designated, the policy guidance is provided to this command by the Joint Chiefs of Staff. Component commands are provided with policy guidance from the Joint Chiefs of Staff; however, since they are composed of units from a single service, their internal spectrum management conforms to that of their parent service.

Navy requests for the use of a frequency outside the United States & Possessions are submitted to the Navy component command, i.e., Commander in Chief United States Pacific Fleet (CINCPACFLT), who may make an assignment from a pool of frequencies or forward the request to the theatre commander, i.e., Commander in Chief Pacific (CINPAC). The unified commander may make an assignment if the frequency is for intra-threatre communications-electronics requirements and all of the following requirements are met:

1) United States national and/or international protection is not required, i.e., registered with the Interdepartment Radio Advisory Committee or the International Frequency Registration Board.

2) Interdepartment Radio Advisory Committee and Federal Communications Commission jurisdictional areas are not involved. This requirement may be waived in the case of tactical and/or training operations.

3) Appropriate coordination has been accomplished with host governments and/or local offices of

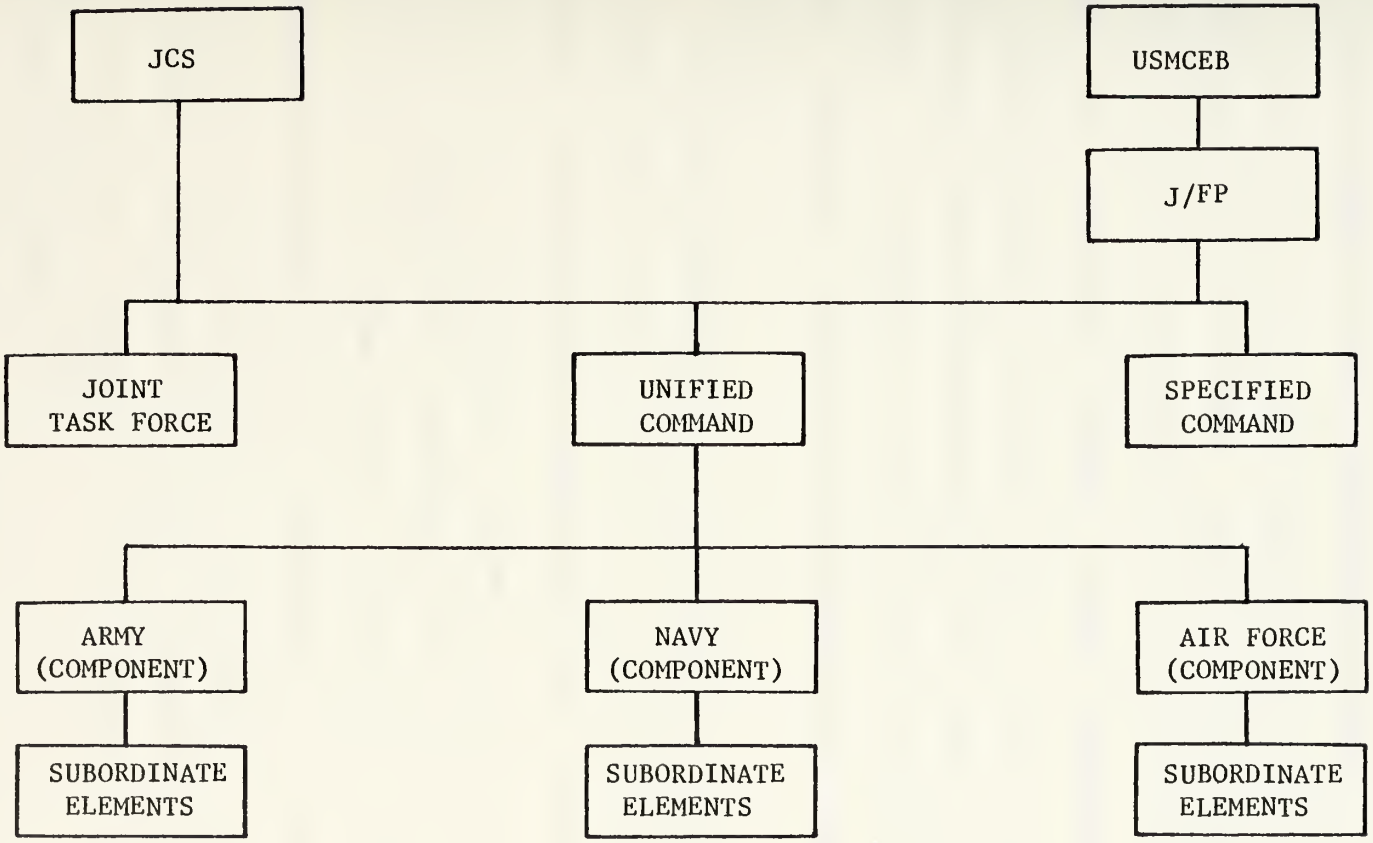
U.S. Governmental agencies.

4) Harmful interference will not result to users whose frequencies are registered with the Interdepartment Radio Advisory Committee or the International Frequency Registration Board.[88]

Although the above requirements may be met in making a frequency assignment, the assignment is subject to change by the Military Communications-Electronics Board in order to make room for new military or non-military systems.[89]

If the unified commander cannot make a frequency assignment, the request is forwarded to the U.S. Military Communications Electronics Board for assignment action. Figure 8 shows the structural relationship between unified commands, component commands, etc., and the Joint Chiefs of Staff and the U.S. Military Communications-Electronics Board. This figure represents the flow of frequency management authority for military matters worldwide.

Figure 7 shows that if the frequency is for use outside the United States & Possessions, the Navy must conduct all local area coordination, i.e., coordination with the area unified commander, host country coordination, and coordination with other U.S. Government Agencies in the area. After this coordination is completed, the assignment request is forwarded to the Navy Electromagnetic Spectrum for presentation to the Joint Frequency Panel (J/FP) of the U.S. Military Communications-Electronics Board for assignment action. The figure shows that the first step is the submission of the frequency request, complete with local coordination documentation, to the Navy component command. If the Navy component command



Department of Defense
Frequency Management Structure
Figure 8

cannot satisfy the request, it is forwarded to the unified command for his action. Finally, if the unified command cannot satisfy the request for assignment, it is forwarded to the Military Communications-Electronics Board for action.

The unified commander conducts the host country coordination that is required. This coordination is done via one of the treaty organizations to which the United States belongs, e.g., the North Atlantic Treaty Organization's Allied Radio Frequency Agency Permanent Staff, under the Military Committee and the International Military Staff for Communications-Electronics. In addition to host country coordination, the unified commander's staff also conducts intra-theatre coordination.

Frequency coordination with the host country is especially important in view of the way in which frequencies are allocated by both specific telecommunication service and geographical area. For example, frequencies used for a specific service in International Telcommunication Union Region 2 (the Americas) may cause harmful interference with the telecommunication services of the host nation situated in another International Telecommunication Union region. It is the policy of the Federal Government to assign frequencies in accordance with international agreements and International Telecommunication Union allocations.[90]

If the frequency assignment request cannot be satisfied by the unified commander, it is forwarded to the Joint Frequency Panel of the U.S. Military Communications-Electronics

Board. The overall coordination and assignment of frequencies is done by the Joint Frequency Panel for overseas assignments.

The frequency assignment request is actually forwarded to the Joint Frequency Panel via the Navy Electromagnetic Spectrum Center for Navy user requests. The Joint Frequency Panel then ascertains that the request is in compliance with appropriate international treaties and agreements concerning communications-electronics matters. Once all of this is done, including coordination with other non-military U.S. Government agencies in the host country, and the assignment is approved by the Joint Frequency Panel, the approved assignment is returned to the Navy Electromagnetic Spectrum Center for authorization for use by the Navy requester. All other concerned military echelons of command are notified of the assignment at this time by separate correspondence.

Frequency assignments are registered with the International Frequency Registration Board of the International Telcommunication Union only if there is a requirement by the requester to obtain international recognition of the frequency. The registration of frequencies is made by the International Notification Group of the Interdepartment Radio Advisory Committee.

B. NAVY FREQUENCY MANAGEMENT

References have been made to the frequency management process within the Department of the Navy. At this point some of the details of spectrum management within the Navy will be discussed. The major players in the Navy frequency management

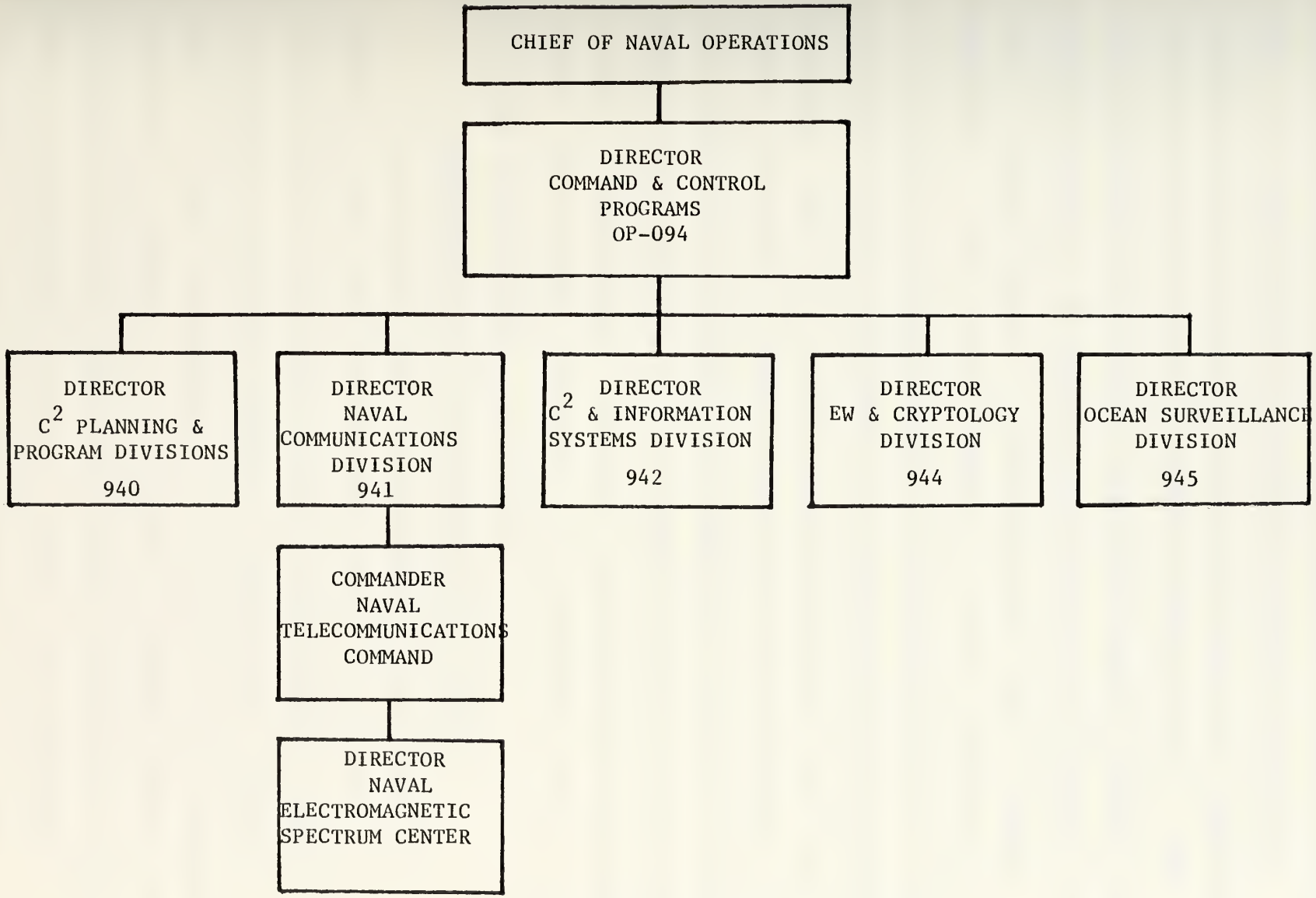
hierarchy starting at the highest level with the Chief of Naval Operations will be briefly described. Figure 9 shows the organizational relationship between the players discussed below.

1. Chief of Naval Operations

The Chief of Naval Operations is charged by the Secretary of Defense with the responsibility to effect review, coordination, and approval of applications for frequency allocation/assignment submitted by activities of the Department of the Navy.[91] The Chief of Naval Operations does not actually perform these functions, but has delegated them as shown below. The role of the Chief of Naval Operations is similar to that of a chief executive officer in a large corporation, i.e., although he may be tasked with the ultimate responsibility for the organization, the chief executive officer may delegate some decision-making to lower echelons.

2. Chief of Naval Operations, Director Naval Communications Division (OP-941)

The Director Naval Communications Division has been delegated the responsibility by the Chief of Naval Operations for promulgating overall policy guidance and direction to the Department of the Navy in frequency management and electromagnetic compatability matters. Specifically, he is delegated the responsibility for reviewing, coordinating, and approving applications for frequency allocations. The Director has the authority to waiver electromagnetic compatability standards for new system developments. The Director also has



Partial Navy Department Structure
Figure 9

the responsibility for determiing current and future requirements for communications-electronics equipment/systems to accommodate Navy and Marine Corps requirements for communications-electronics support in mission accomplishment. This last responsibility includes obtaining frequency support for required systems. To assist the Director in his duties the Chief of Naval Material is required by the Chief of Naval Operations to verify that frequency allocation applications are submitted and approved prior to obligating funds for the development and/or procurement of communications-electronics equipment. This is in keeping with national policy.[92] An approved frequency allocation authorizes the development of telecommunication equipment for subsequent operation in the frequency band specified.[93] In essence the role of the Director Naval Communications Division is to determine requirements and then take whatever planning and procurement actions are necessary to meet those requirements.

3. Commander Naval Telecommunications Command

The Commander Naval Telecommunications Command is required by the Chief of Naval Operations to provide advice and assistance to the Chief of Naval Operations in support of the frequency allocation process to support Navy communications-electronics requirements and the Navy's electromagnetic compatibility program. The Commander is responsible for the procurement of radio frequencies through coordination, allocation, and assignment actions. Further, the Commander is responsible for testing and operational use of the Navy

Telecommunication System. Essentially the role of the Commander Naval Telecommunications Command is that of senior manager of the Naval Telecommunications System and as such he is responsible for its operation and maintenance. This role as manager also includes developing, maintaining, and promulgating a manual of procedures for radio frequency spectrum management--Naval Telecommunications Publication-6 (NTP-6).

4. Frequency Allocation Advisory Board (FAAB)

The Frequency Allocation Advisory Board[94] was established in 1957, to provide a forum for discussing matters of mutual concern among Navy Department actitivies charged with assessing electromagnetic compatability. The mission of the FAAB is to provide the Director, Naval Communications Division with advice and assistance concerning:

1) the procurement, allocation, assignment, and protec- of radio frequencies required for Navy Department use;
2) the analysis and evaluation of the Navy's electromagnetic compatability program;
3) the development and operation of electronic devices to reduce electromagnetic interference; and,
4) the monitoring of the progress of the Navy Department's implementation of the Department of Defense's Electromagnetic Compatability Program and commensurate Navy Department responsibilities.

5. Navy Electromagnetic Spectrum Center (NAVENSCEN):

The Director, Navy Electromagnetic Spectrum Center, who is also the Special Assistant for Frequency Management (SAFM) under COMNAVTELCOM, is charged with numerous duties as outlined in COMNAVTELCOM letter Serial SAFM/6003 dated 17 May 1978. Essentially, the Director, NAVEMSCEN is delegated the actual allocation/assignment authority for the Department of the Navy. He is responsible for the day-to-day procurement, protection, allocation, and assignment of frequencies for communications-electronics equipment and systems in the Navy. He also conducts coordination and liaison with other Government and non-Government users of the radio frequency spectrum. The NAVEMSCEN also provides the staff support and representation on:

a. U.S.C.C.I.R. (International Radio Consultive Committee) National Committee;

b. Interdepartment Radio Advisory Committee (IRAC);

c. Joint Frequency Panel (J/FP), USMCEB; and,

d. Ad hoc working groups of the IRAC.

6. Fleet Commanders in Chief (CINC'S)

The Fleet Commanders are responsible for the coordination and use of radio frequencies within the Fleets and for coordination with unified and specified commanders, as appropriate. He is assisted by the local Naval Communications Area Master Station (NAVCAMS). Each NAVCAMS is given a specific area of responsibility as outlined in NTP-6. Further, the Fleet Commander is required by the provisions of NTP-6

to coordinate the use of radio frequencies by fleet units adjacent to or within areas of responsibility of Naval District Commandants.

7. Naval District Commandants

Naval District Commandants are responsible for the coordination and use of radio frequencies for Naval shore activities within the district and for coordination with unified and specified commands in those areas located within their area of responsibility. The only exception to this is if a Naval Telecommunications System (NTS) activity exists in that district. In this case the District Commandant has no responsibility for the coordination of frequencies (used by the NTS activity) with other District Activities.

8. Installation Commanders

Installation (base) commanders are responsible for the use of radio frequencies within the confines of the installation. The use of radio frequencies by a tenant activity onboard a USN/USMC installation are included in host-tenant agreements.

C. RECOMMENDATIONS

One aspect of the hierarchy presented in this chapter is the number of activities charged with the management of the radio frequency spectrum. Each of these activities has basically the same responsibility--to coordinate the assignment and use of radio frequencies in order to prevent electromagnetic interference (EMI). Yet, in a personal interview with

the author, the Frequency Manager at the Naval Communications Area Master Station, Eastern Pacific (NAVCAMS EASTPAC) at Wahiawa, Hawaii, stated that about two-thirds of the high-frequencies currently in use experience some degree of man-made interference. The majority of this interference comes from U.S. military sources. With so many activities engaged in the management of the frequency spectrum, how is this possible?

There are undoubtedly many reasons for this phenomenon. However, the author has chosen two issues which he believes have significant impact on this problem: 1) training and experience (a manpower issue) and 2) the structure of the hierarchy itself.

The first issue is the lack of experience and training given to the personnel assigned to frequency management billets. The Commander in Chief, Pacific's Frequency Manager (J-611) has stated,

> Most assigned personnel have never had more than one tour as a spectrum manager and for the most part that is the one they are presently serving.[95]

Further, the Defense Audit Service says,

> Present training programs are not producing the personnel needed to replace frequency managers that will be lost through attrition over the next 5 to 10 years. . . Although there is a relatively high number of military personnel in frequency management, the attrition of civilians will result in a reduction in total managers, both military and civilian. The loss of civilian personnel is especially critical because of the continuity they provide in this highly technical area.[96]

The author believes that there are two main implications in this statement. First, new personnel are not being added

to the frequency management ranks in sufficient quantity to maintain the current level of manning. The problem stems from the difficulty in identifying potential personnel losses sufficiently in advance to place trainees into the frequency management training pipe-line. This would permit filling vacancies as they occur. Second, that despite the large number of military frequency managers, their high turnover rate adversely affects the continuity needed in frequency management. This turnover in military frequency managers seems to be designed into the system, as indicated in the Joint Chiefs of Staff Comments below.

> We must expect the frequency management specialty for officers to be subjected to the same assignment criteria applied to other career areas. That is, some frequency managers will receive their first career duty assignment straight to the field from the classroom. Frequency Management is a specialty within the telecommunications career field and, therefore, officers will move into and out of the speciality due to the need to broaden their telecommunications background in preparation of command assignments. To do otherwise could severely limit the officer's career progression. Efforts are made to retain identification of officers trained in frequency management so that they may be recalled to the specialty should the need arise. A major concern now is the high percentage of frequency management officers in the 05/06 ranks approaching retirement. (Author's note: there is only one 06 frequency manager in the Navy and he is retiring in the immediate future). We will be addressing this problem to the Services shortly. . . .[97]

The Joint Chiefs of Staff have responded to charges of a lack of training programs made by Commander in Chief Pacific's Frequency Manager noting that there are training programs in use for both military and civilian personnel.[98] A major problem is that, for example, the training course

offered by the National Telecommunications & Information Administration takes about six to nine months to complete. Although this program is designed to train civilians it has proven difficult to channel personnel into the training program in the appropriate numbers of civilian personnel management procedures.

> . . .very few incumbent civilian DoD frequency managers have a guaranteed 6-9 months notice of retirement or resignation, which requires signing a Standard Form 52 (SF52). In fact, a civilian is not required to give prior notice of retirement and can submit the SF52 the day before retirement. This obviously makes it difficult for the Department of Defense to use the. . . program for personnel replacement due to retirement.[99]

The problem then becomes one of trying to deal with the civilian personnel management system as well as trying to maintain a trained cadre of frequency managers.

If the objective of the Joint Chiefs is to develope well-rounded career telecommunications officers, this officer rotation strategy will achieve the desired results. If, however, the Joint Chiefs want to develop experienced military frequency managers, this rotation strategy would appear to be counter productive. Further the authors sees the Joint Chiefs' statement, ". . .so that they may be recalled to the specialty should the need arise. . . ." as indicative of the Joint Chiefs' view that it is easy for the former frequency manager to reconstitute his skills and function again as a frequency manager. The author views this statement as ignoring the changing nature of frequency management techniques (i.e., in response to the increased congestion of the spectrum, improvements in telecommunications equipment, etc.).

Captain J.A. Madigan, Special Assistant for Frequency Management, Commander, Naval Communications Command, in an article advocating the development of professional frequency managers, has stated that the decision makers must answer the question of whether or not the military is planning to respond to the electronic challenge laid down by United States' potential adversaries. He views this challenge as the development of new and better communications-electronics systems. To do this he says,

> If we are to keep pace we must expend an adequate investment in spectrum management personnel. . . . All levels of command should come to recognize that radio frequency spectrum management is no longer an exercise in precise record keeping. Frequency managers are part of a highly complex professional field where sophisticated, talented individuals compete for space in the radio frequency spectrum, rule on new techniques, devise procedures, resolve interference, manage and proscribe radio frequency utilization. . . . Like other resources, it can be polluted (harmful interfernce), and it is dependent upon. . . effective management for use.[100]

The General Accounting Office echoes Captain Madigan's concern,

> . . .availability of people skilled in spectrum management has not kept pace with increased demands and economic and technical complexities associated with extended use of the spectrum.[101]

The emphasis of the above statements is that increased use of the radio frequency spectrum demands an increase in both the number and level of talent/skill of frequency managers. Further, it is important that all levels of command come to appreciate the importance of frequency management in the use of the radio frequency spectrum. And finally, that personnel assigned to frequency management billets should be rotated to

other non-frequency management billets less often, thus having more opportunity to increase their skills.

The second issue which the author will discuss is the structure of the military frequency management hierarchy. One important aspect of the organizational structure is how authority to make decisions is distributed within the hierarchy.[102] This is an especially important issue in the case of Commander in Chief Pacific's Frequency Manager.

Allied Communications Publication 190 U.S. Supplement-1(B) outlines the responsibilities of unified commanders and military departments in frequency management. Unified commanders are given coordination and assignment responsibility within their geographical area of responsibility.[103] The military departments (Army, Navy, and Air Force) are,

> . . .responsible for the coordination and assignment of radio frequencies in CONUS and for the coordination of frequencies among civil and Government agencies within the United States and Possessions.[104]

In areas under the jurisdiction of the National Telecommunications & Information Administration, military departments must coordinate with other agencies but get frequency assignments from the Frequency Assignment Subcommittee of the Interdepartment Radio Advisory Committee.[105]

The assignment authority of the unified commander has been limited, as previously stated, so that he may not make assignments in areas under the jurisdiction of the National Telecommunications & Information Administration, i.e., the United States & Possessions. In the case of the Pacific area this puts the Commander in Chief Pacific in an untenable position

with regard to frequency assignment control. On one hand the unified commander is required by the Joint Chiefs of Staff to be the ". . .final frequency coordination authority. . ." within the Pacific area. Hawaii falls under the jurisdiction of the National Telecommunications & Information Administration. Service components of the Pacific command, therefore, get their frequency assignments from the Frequency Assignment Subcommittee vice the unified commander. The author believes that this effectively usurps the Commander in Chief Pacific's control over military frequency assignments within the Hawaii area.[106] The author has defined control as assignment authority. The author believes that this definition is in keeping with the intent of the cited literature.

The author believes that the distribution of assignment authority within the hierarchy places the unified commander at a disadvantage in controlling frequency assignments within his area of responsibility. Here control means the ability to approve/disapprove assignments. The military department has an avenue via the Frequency Assignment Subcommittee to get frequency assignments which are not controlled (approved/disapproved) by the unified commander.

The author recommends that this assignment-authority issue be clarified in such a way that the unified commander has final assignment authority in his geographic area of responsibility. If the unified commander is not to be the final assignment authority in his area of responsibility, as a minimum, all frequency applications should be forwarded to Washington via the

unified commander's frequency manager. This would give the unified commander an opportunity to attach comments/recommendations to the application informing Washington level authority of potential problems of inappropriate assignements, i.e., assignments which have a high probability of causing harmful interference.

The author believes that this is especially important in light of the unified commander's task as assigned by the Joint Chiefs of Staff. The Joint Chiefs of Staff have tasked the unified commander with the integration of multi-Service forces for the accomplishment of a broad continuing mission.[107] In the Pacific area, for example, this mission is to defend the United States against attack in the Pacific Ocean area; to support and advance the national policies and interests of the United States; and carry out U.S. Military responsibilities in the Pacific Ocean area.[108] The integration of multi-Service forces in the accomplishment of the Joint Chiefs of Staff's assigned mission includes the integration of the individual component command radio frequency requirements. The purpose of this radio frequency requirements integration is to prevent or reduce electromagnetic interference between communications-electronics systems. One way to achieve the integration of frequency requirements is the assignment of required frequencies to the component forces by a single entity, i.e., the unified commander.

In the United States & Possessions disputes concerning frequency assignments between the unified commander (acting

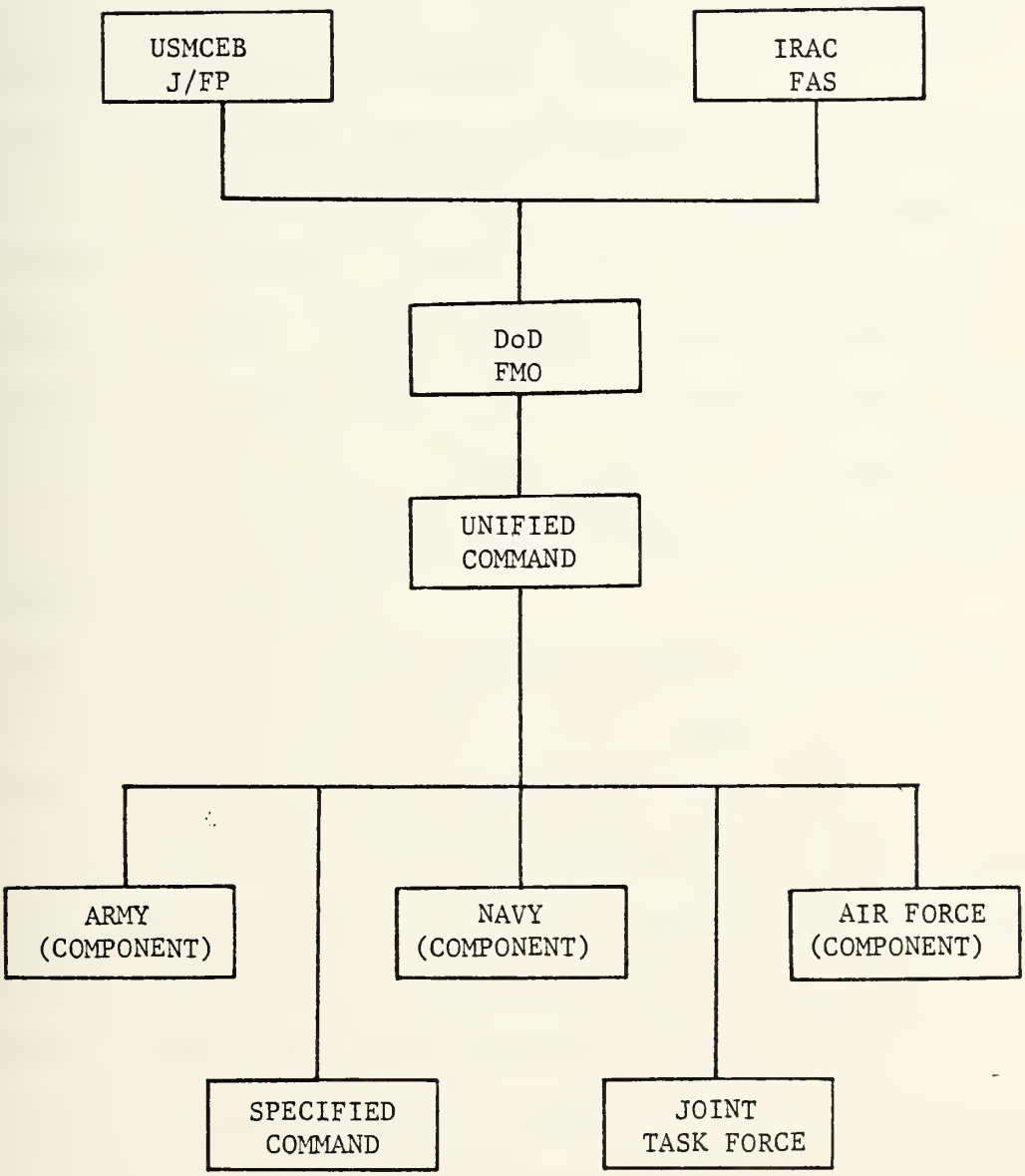
as the defacto area frequency coordinator) and other military/non-military Government agencies or civil entities could be resolved via the Interdepartment Radio Advisory Committee mechanism. Outside the United States & Possessions similar disputes could be resolved via the U.S. Military Communications-Electronics Board mechanism.

In either case, it is important that the organization of frequency management comply with several guidelines for effective management.[109] First, clarity is essential. Each entity within the organization needs to know where it belongs; where it stands; where to go for information, decisions, and cooperation; and how to get what it needs. In the case of a unified commander such as Commander in Chief Pacific, his position of in the control of frequency assignment/use in the Pacific area needs clarification. If the Commander in Chief Pacific is to be the frequency assignment/use authority in the Pacific, then all requests for frequency assignments must, at a minimum, be submitted to Washington via the unified commander's staff. A better solution, in the author's opinion, is to give broader frequency assignment authority to the unified commander. Second, entities need to be oriented toward achieving overall organizational results, not just toward individual efforts. The component commands need to satisfy their frequency requirements, but not at the expense of mutual interference with the unified commander's command and control frequency requirements. Third, decisions should be made at the lowest possible level consistent with the information required for making that decision

is available. The unified commander's staff can be provided with the necessary manpower and documentary resources to satisfactorily conduct inter-theatre, inter-organizational, and international coordination. Further, who is better equipped to evaluate the communications-electronics environment in the area of the coordination efforts than personnel on the scene of the required coordination? Adquate policy and guidance can be provided to the unified commander so that the politically and militarily acceptable decisions can be made by the unified commander.

The author proposes that a military frequency management hierarchy as shown in Figure 10 be adopted. This figure graphically represents the proposed management, coordination, and assignment authority chain of command worldwide for the military. This figure shows the creation of a Department of Defense Frequency Management Office (DoD FMO). This office would be the result of the colocation of the individual Service frequency management offices in Washington. Secondly, broader authority and responsibility would be given to the unified commander in that any specified command or joint task force operating in the area of responsibility of a unified commander would get frequency assignments or, at least, frequency use authorization from the unified commander.

The author believes that this proposal will give the unified commander authority as the ultimate frequency coordination/assignment authority in his geographic area of responsibility.[110]



Proposed
Military Frequency Management
Hierarchy
Figure 10

Another part of this proposal by the author is the colocation of the military departments' frequency management offices (FMO'S). Currently, the Army frequency management office is located in the Pentagon; the Air Force office is at Bolling Air Force Base, Washington, D.C.; and the Navy frequency management office is at Cheltenham, Maryland.

The Defense Audit Service states the colocation of these frequency management offices has several benefits aside from the monetary savings in reduced travel costs incurred in attending meetings. Major benefits are the elimination of the existing separate data banks and automated data processing facilities; reduction of message traffic for frequency management; and consolidation of administrative functions required in frequency management.[111]

This colocation of the Service frequency management offices could be utilized to provide a single Department of Defense representative on the Interdepartment Radio Advisory Committee. The Defense Audit Service believes that this reduction is more cost-effective in terms of personnel and would provide a unified Department of Defense position on matters of Interdepartment Radio Advisory Committee interst.[112]

Of the eighteen permanent members on the Interdepartment Radio Advisory Committee, three are from the Department of Defense. Although this seems to give the Department of Defense numerical advantage in the voting procedure, the Defense Audit Service believes that the Committee's basic function is to provide assistance to the Director, National

Telecommunications & Information Administration as outlined in Table 1. The Committee and its subgroups vote on matters brought to their attention. Unless there is unanimous agreement, the matter is usually referred to the National Telecommunications & Information Administration for resolution.[113] The author agrees with the position of the Defense Audit Service that under these circumstances there is no advantage to having a numerical advantage for the Department of Defense.[114] Therefore, there is no reason to maintain all three Service representatives on the Interdepartment Radio Advisory Committee.

The author suggests two methods for selecting the Department of Defense representative for the Interdepartment Radio Advisory Committee. The first is for the frequency management offices of the Services to elect a representative from their number to be the Department of Defense's representative on the Interdepartment Radio Advisory Committee. Second, the representative on the Interdepartment Radio Advisory Committee could be chosen from the civilian staff of the colocated frequency management offices. This second method takes advantage of the continuity of the civilian staff as the embodiment of the Department of Defense corporate knowledge and stability, i.e., lower turnover rate than the military staffs.

The author's intent has been to demonstrate that overlapping areas of responsibility for frequency management-assignment, particularly in the Pacific theatre, make the

coordination and assignment of radio frequencies unnecessarily difficult. These overlapping responsibilities lead to mutual interference in frequency use. This inteference could be reduced or prevented by allowing frequency assignment by the area commander, i.e., the unified commander.

An important factor contributing to the interference problem is the time it takes to process a frequency assignment request through the centralized assignment system. Informed sources on frequency management staffs say that the processing of assignment requests by Washington can take 60-90 days. Meanwhile, users will utilize whatever frequency they choose to satisfy their immediate needs while awaiting Washington's action. Often this use will cause interference with other users.

The author believes that his proposal for making the unified commander the assignment authority in his geographical area of responsibility could alleviate this problem by 1) reducing the time between request for a frequency and final assignment from months to days, and 2) by allowing the onscene commander who is acutely aware of the radio frequency emmission environment in his area to make assignments.

The author also believes that making the unified commander the frequency assignment authority in his geographical area of responsibility will enhance the unified commander's knowledge of his subordinate component command's communications-electronics suites. This knowledge is important in the unified commander's contingency planning for the employment of forces for mission accomplishment.

The author's suggestion to colocate the Service frequency management offices is not new nor is it unique. The Defense Audit Service's report states that this colocation has been suggested before, but has yet to be implemented. The author believes that this colocation is being resisted because of the Service's beliefs. Each Service believes its requirements are so unique that only the Service can analyze the problem. However, the author also believes that this colocation may eventually be mandated due to budget and manpower constraints in supporting three frequency management offices. It, therefore, behooves the Services to make the move to colocation and establish a system of the Services' choice before a colocation is imposed.

V. CONCLUSION

The Administrator, National Telecommunications & Information Administration, Henry Geller, has pointed out that even though technology may expand the supply of spectrum, many spectrum users still perceive a shortage in the near future.[115] Mr. Geller has stated that this perceived scarcity has revealed inefficiencies in United States spectrum management practice. The author concurs with Mr. Geller in general and in particular when he says,

> The spectrum, if properly conserved through sound management, could accommodate foreseeable future needs.[116]

Future radio frequency scarcity is an indication of the adequacy of administrative techniques for managing the spectrum resource. The technical resources for enhancing spectrum management are improving. For example, computers can be employed to provide rapid electromagnetic compatability evaluation of proposed frequency allocations and assignments. Computer software can be designed to provide alternative choices for frequency selection. The author believes these computer decision aids reduce the need for frequency management personnel to have "long experience" as Admiral Boyes suggests,

> Radio frequency management is done by experts who meld years of experience with a curious blend of regulations, electronics, politics and not a little bit of larceny. They justify requirements, horse-trade, coerce, bluff and gamble with an institution that cannot be taught other than by long experience.[117]

While the author believes that frequency management decision aids will reduce the need for investment in specific human capital vice on the job experience, it will never eliminate it. Rather vice education and training in communications-electronics and data processing these personnel will be able to utilize more complex computer based decision aids for conducting electromagnetic interference analysis and other aspects of frequency management. This use of education and training is a more efficient method of obtaining qualified personnel.

Therefore, perceived radio frequency spectrum scarcity is amenable to administrative solution if the personnel assigned to frequency management billets are adequated educated and tained, have experience, and are provided with decision-making aids.

Because spectrum scarcity is largely an administrative problem subject to administrative solution, administrative procedures for allocating and assigning frequencies will determine the actual number of radio frequency spectrum users. In view of the administrative nature of the solution of spectrum scarcity, the distinction between Government and non-Government users appears artificial. To successfully implement an administrative solution to spectrum scarcity the notion that any portion of the spectrum can be dedicated solely to one user or the other must be dispelled. One of the first tasks involved in dispelling this notion is convincing Government and non-Government users that sharing previously dedicated portions of the spectrum will not preclude its future use

by either party. More than forty percent of the usable spectrum is currently shared by Government and non-Government users.[118] The fear of losing access to spectrum through sharing of the spectrum with others must be overcome. The author believes that a spectrum sharing plan will force both Government and non-Government users to more carefully analyze and justify frequency requirements. This plan should also include frequency usage review procedures to return unused frequencies to a stockpile for future reassignment.

But to adequately manage a shared spectrum, a management system which discards the distinction between responsibilities for Government and non-Government use of the radio frequency spectrum must be developed. In the author's opinion, such a system virtually demands a centralized management agency. Knowledgeable sources see this centralized management function residing within the Executive Office of the President. Such a centralized system should be based upon the following principles:

1) The agency managing the spectrum must have the authority to carry out its management function. This authority must include the authority to establish and enforce sufficiently detailed technical rules governing the frequency assignment process.
2) A common frequency management data base and decision aid must be established. This data base and decision aid must include frequency usage

information as well as software capable of flagging potential conflicts in frequency assignments and recommending more feasible assignments. Frequency usage data would be useful to enable reassignment of idle frequencies.

3) Frequency review procedures to prevent under or over utilization of portions of the spectrum.
4) Government and non-Government frequency authorizations should be based on public hearings to the maximum extent possible consistent with National Security.
5) Although a part of the Executive Branch, this central body must be independent of all agencies and would be solely responsible to the President for overall spectrum management in the United States.

Currently, Government and non-Government users go their own ways interacting only at the Interdepartment Radio Advisory Committee and then in an adversary role, e.g., any member of the Committee may request referral of frequency management matters to the National Telecommunications & Information Administration for resolution. In extreme cases, some issues may be referred to the Office of Management and Budget for resolution.

The ultimate problem, however, remains the development of an adequate system to evaluate competing uses of spectrum. It is extremely difficult to measure the opportunity costs of frequencies used by Department of Defense agencies in a

National defense role versus other Government or non-Government uses. It is difficult to assess in what way many Department of Defense spectrum uses affect National defense objectives. Further work needs to be done in this area.

The author has attempted to present an overview of the frequency management structure in the United States as it relates to the Navy. The author believes this thesis presents a picture of the complexity of frequency management mechanisms in the United States.

VI. TABLE 1
NATIONAL LEVEL
FREQUENCY MANAGEMENT ORGANIZATIONS

Interdepartment Radio Advisory Committee (IRAC)

The mission of the IRAC is to assist the Assistant Secretary of Commerce for Communications and Information (Administrator, National Telecommunications and Information Administration) in the discharge of his responsibilities pertaining to the use of the electromagnetic spectrum, as contained in Executive Order 12046.

The basic functions of the IRAC are to:

1. assist the Assistant Secretary in assigning frequencies to Federal Government radio stations;

2. assist in developing and executing policies, programs, procedures, and technical criteria pertaining to the allocation, management, and use of the spectrum; and,

3. approve, in collaboration with the FCC, the allocation of frequency bands to radio services in the US & P.

FREQUENCY ASSIGNMENT SUBCOMMITTEE (FAS) of the IRAC

The normal function of the FAS is to assist the IRAC in assigning frequencies to Federal Government radio stations and in developing and executing policies, programs, procedures, and technical criteria related to the assignment and coordination of radio frequencies and in the development and execution of procedures therefor. The FAS actually does the assignment of frequencies for the IRAC and only irreconcilable differences are referred to the IRAC for resolution.

TABLE 1-1

ASSISTANT SECRETARY OF DEFENSE for COMMUNICATIONS, COMMAND, CONTROL, and INTELLIGENCE (ASD C^3 &I):

ASD C^3 &I has functional responsibility for overall policy and coordination in the area of management and use of the radio frequency spectrum.

JOINT CHIEFS OF STAFF (JCS)

1. Provide overall policy guidance to Services concerning joint and inter-Service military frequency management matters.

2. Determine headquarters communications support required for unified and specified commands and recommended the assignment to individual Services the responsibility for providing that support.

MILITARY COMMUNICATIONS-ELECTRONICS BOARD (MCEB)

The mission of the MCEB is:

1. Achieve coordination on military communications-electronics matters among DoD components, between the DoD and other Governmental departments, and between the DoD and representatives of foreign nations.

2. Provide the DoD with guidance and direction in those functional areas of military communications-electronics for which the MCEB is responsible.

3. Furnish advice and assistance, as requested, on military communications-electronics matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments, and other DoD components.

Specifically, the MCEB:

TABLE 1-2

1. is responsible for developing policy and procedures incident to frequency engineering and management within the DoD, with other Governmental agencies, and between the DoD and representatives of foreign nations;

2. provides joint and inter-Service military frequency engineering and management;

3. provides frequency engineering and management assistance, as requested, to the Secretary of Defense, the Joint Chiefs of Staff, the military departments, and other DoD components;

4. prepares and implements procedures for participation in the DoD Electromagnetic Compatibility Program (EMCP);

5. manages the Frequency Resource Record System (FRRS) which is designed to:

a. provide electronic data processing support to the military departments for the reporting of frequency usage, and

b. satisfy the requirements of DoD components for frequency engineering and management, and supply basic data required for performance of electromagnetic compatibility analysis; and

6. implements radio frequency management and utilization policy handed down by the Joint Chiefs of Staff.

JOINT FREQUENCY PANEL (J/FP of the MCEB)

The mission of the J/FP is to review, develop, and coordinate studies, reports, DoD positions and Directions, and recommendations of the MCEB in the area of radio frequency engineering and management, radio wave propagation, and electromagnetic compatability.

TABLE 1-3

The J/FP performs, among others, the following functions:

1. Develop, review, and recommend plans, policies, methods, and procedures for frequency management;

2. Recommend operational and technical characteristics for systems and equipments;

3. Review and recommend principles and procedures for obtaining compatibility of systems and equipments;

4. Prepares recommendations for insuring coordination of research and development with a view to reducing or possibly eliminating duplication or deficiencies in envisaged spectrum use;

5. Prepare radio frequency guidance to DoD components concerning the procurement and/or development of communications-electronics equipment designed purposely to radiate or receive electromagnetic energy;

6. Coordinate with other military, Government, and foreign military concerning communications-electronics matters; and,

7. Coordinate and assign frequencies to meet military requirements.

AREA FREQUENCY COORDINATOR (AFC)

1. Review and evaluated frequency assignment requests proposed for use within their area of responsibility.

2. Provide any activity within their area of responsibility technical comments concerning the probability of harmful interference which might be caused or encountered by a proposed application.

TABLE 1-4

3. Assist, when requested, in the elimination of real-time harmful electromagnetic interference to in-being range and test site operations. In performing this function, the AFC'S are authorized to request temporary radio silence on a frequency or band of frequencies on the part of any interferring activity for the period of time necessary to complete the operation in progress.

4. Recommend a frequency based on an applicant's requirements and the technical particulars furnished by the applicant. The AFC will inform the applicant of the probability of any harmful interference involving the proposed assignment, and if appropriate, will recommend alternatives and/or restrictions to preclude such interference. The AFC'S comments to the applicant will be based on his records of spectrum usage in his geographical area of responsibility and such additional coordination with other activities in that area as he deems appropriate. The applicant must include the AFC'S comments on his frequency assignment request.

5. In CONUS, AFC'S may, by mutual agreement among military activities within their geographical area of responsibility, arrange for time sharing and technical adjustments (emmission, output power, etc.) of frequency assignments as required to preclude conflicts. In areas under the jurisdiction of a unified commander, arrangements of this type will be coordinated with the appropriate unified commander.

TABLE 1-5

6. The AFC must maintain current records of all frequencies coordinated and/or assigned for use in their areas. These records will include frequencies assigned to military activities, military contractors, and those Government and non-Government assignments being shared with test range frequency assignments.

UNIFIED AND SPECIFIED COMMANDS

1. Final frequency coordination authority in their geographical area of jurisdiction.

2. Maintain records of frequencies assigned to military activities within their area of responsibility.

TABLE 1-6

VII. FOOTNOTES

1. The concept of organizational structure has many facets. Richard H. Hall in his book Organizations: Sturcture and Process (Englewood Cliffs: Prentice-Hall, 1977) discusses many of the facets, but in general, structure is concerned with the division of labor; people have different tasks within the organization. Further, structure has to do with ranks or a hierarchy; the positions that people fill. These positions have rules that specify, to varying degrees, how incumbents are to behave in their positions.

2. Hertz is the unit of measure of radio frequency. One hertz is one cycle per second. The hertz is named after Heinrich Rudolph Hertz, German physicist (1857-1894), who discovered electromagnetic radiation.

3. Jora R. Minasian,"Property Rights in Radiation: An Alternative Approach to Radio Frequency allocation," The Journal of Law and Economics, XVIII (April, 1975), 222.

4. Note, however, that the spectrum cannot be subdivided into smaller channels without limit. The frequencies used to define a channel of communication are not just numbers limitlessly subdividable into smaller numbers. Just as two cars cannot occupy the same space simultaneiously without adverse results--called an accident--two radio signals of the same frequency and amplitude cannot simultaneously occupy the same geographical space. Each radio operation requires a finite portion of the spectrum--called a channel--in time and space.

5. This technique is described in a paper given at the Seventh Technical exchange Conference held at El Paso, Texas, 30 November-3 December 1976. The paper is entitled "Prophet: Real Time Propagation Forecasting Terminal" by Juergen H. Richter, Ilan J. Rothmuller, and Robert B. Rose all of the Propagation Division, Naval Electronics Laboratory Center, San Diego, California.

6. George A. Codding, Jr., The International Telecommunication Union, An Experiment in International Cooperation (Netherlands, 1952), p. 19.

7. Vernon T. Williams and Martin K. Collins, "The Radio Spectrum International Allocation and Regulation" (unpublished Master's thesis, Naval Postgraduate School, Monterey, 1979), p. 16.

8. National Telecommunications & Information Administration, Manual of Regulations & Procedures for Federal Radio Frequency Management (Washington: Government Printing Office, January, 1979 Revision), p. 3-5. (Hereafter referred to as NTIA Manual).

9. Williams and Collins, op. cit., p. 80.

10. John Walsh, "Encounters with the Third World Seen in Allocating Frequencies," Science, 201:4355 (11 August, 1978), p. 513.

11. Stephen Grove, International Agreements," Satellite Power System, prepared by the U.S. Department of Energy Office of Energy Research, Satellite Power System Project Planning Office, (McLean, Virginia: PRC Energy Analysis Company, 1978), p. 22.

12. Ibid., p. 77.

13. Joel M. Woldman, "An Introduction to the Foreign Policy Implications of the 1979 WARC." Washington, D.C.: Specialist in U.S. Foreign Policy, Foreign Affairs, and National Defense Division, Congressional Research Service, 31 March, 1978. (Mimeographed.)

14. Walsh, loc. cit.

15. Edward McWhinney (ed.), The International Law of Communications (Dobbs Ferry: Oceana Publications Inc., 1971), p. 53.

16. Paul Harris, US WARC Preparation Draws Congressional Study," Microwaves, 18 (September, 1979), p. 37.

17. Codding, op. cit., p. 460.

18. Ibid.

19. Woldman, op. cit., p. 25.

20. Woldman, op. cit., p. 25.

21. Ibid.

22. Grove, op. cit., p. 67.

23. M. Mili, "International Jurisdiction in Telecommunication Affairs," Telecommunications Journal (International Edition), 40 (March, 1973), 124.

24. M. B. Williams, "International Standards for Telecommunications," Telecommunications in the 1980's and After, A Royal Society Discussion, Sir James Lighthill, Sir Eric Eastwood, C. A. May, and K. W. Cattermole, organizers (Royal Society: London, 1978) p. 187.

25. Williams and Collins, op. cit., p. 9.

26. Joint Technical Advisory Committee of the Institute of Electrical & Electronics Engineers & Electronic Industries Association, Spectrum Engineering--The key to Progress, A Report for Increased Radio Spectrum Utilization (Joint Technical Advisory Committee, 1978), p. 33.

27. United States Department of the Army, Communications-Electronics Management of the Electromagnetic Spectrum (Washington: Headquarters, Department of the Army, 1973), p. 2-3.

28. International Telecommunications Union, Radio Regulations (Geneva: International Telecommunication Union, 1976), p. R5-28.

29. Codding, op. cit., p. 19.

30. United States Department of the Navy, Spectrum Management Manual: NTP-6 (Washington: Government Printing Office, 1975), p. C-3. (Hereafter referred to as NTP-6.)

31. Martha Jane Wheaton, "The Preparations for and the Implications of the General World Administrative Radio Conference of 1979" (unpublished Master's thesis, Naval Postgraduate School, Monterey, 1979), p. 49.

32. Woldman, op. cit., p. CRS-27.

33. MATHTECH Inc. and Telecommunications Systems, Economic Techniques for Spectrum Management: Final Report, by Carson E. Agnew, Donald A. Dunn, Richard G. Gould, and Robert D. Stibolt, p. 16., 20 December 1979.

34. News item in the Telecommunication Reports, 9 July 1979.

35. See Harvey J. Levin, The Invisible Resource: Use and Regulation of the Radio Spectrum for a more complete discussion of stockpiling.

36. Senator Harrison Schmitt, (prepared remarks to Congress, Washington, D.C., 20 June 1978).

37. Woldman, op. cit., p. CRS-25.

38. Williams and Collins, op. cit., p. 60.

39. Walsh, loc. cit.

40. J. H. Wittbrodt, "Long Term Tendencies in Frequency Spectrum Utilization, Rationalization, Development and Administration." Seminar on Frequency Management and the Use of the Radio Frequency Spectrum organized by the International Telecommunication Union (Geneva: International Telecommunications Union, 1976), p. 22.

41. Williams and Collins, op. cit., p. 61.

42. Ibid.

43. Wheaton, loc. cit.

44. Ibid., p. 50.

45. William H. Read, "Foreign Policy: The High and Low Politics of Telecommunications" (Cambridge: Harbard University, 1976), p. 9.

46. Ross A. Webber, Management (Homewood: Richard D. Irwin, Inc., 1975), p. 300.

47. The term politics connotes the process which makes decisions as a result of concessions, concensus, negotiations, and balance of many facets besides pure technology.

48. Woldman, op. cit., p. CRS-24.

49. Executive Office of the President, The Radio Frequency Spectrum, United States Use and Management (Washington: U.S. Office of Telecommunications Policy, 1975), p. A-1.

50. Robert L. Cutts and Leo A. Buss, "U.S. National Spectrum Management" Washington: National Telecommunications & Information Administration, circa 1978), p. 1 (Mimeographed).

51. W. Dean, Jr., "Electromagnetic Compatability and Its Measurement," Seminar of Frequency Management and Use of the Radio Frequency Spectrum organized by the International Frequency Registration Board of the International Telecommunication Union (Geneva: International Telecommunication Union, 1972), Figure 7.

52. Alan Pearce, "NTIA--Washington's Latest Bureaucracy," Telecommunications, September, 1978, p. 37.

53. NTIA Manual, op. cit., p. 1-3.

54. Interdepartment Radio Advisory Committee, 50 Years of Service (Washington: Office of Telecommunications Policy, 1972), p. 1.

55. National Telecommunications & Information Adminstration Manual, op. cit., p. 1-10.

56. National Telecommunications & Information Adminstration, A Summary of the Federal Government's Use of the Radio Frequency Spectrum July 1979. (Washington: Government Printing Office, 1979), Appendix 3.

57. Defense Audit Service, "Report on the Review of Frequency Management within the Department of Defense (Draft)" (Washington: Defense Audit Service, 1978), p. 8. (Mimeographed).

58. Joint Chiefs of Staff, Allied Communications Publication 190 US Supplement 1(B) (ACP-190 US SUPP-1(B)): October 1977 (Washington: Joint Chiefs of Staff, October, 1977), p. B-2 (Hereafter ACP 190 US SUPP-1(B)).

59. Joint Chief of Staff, United Action Armed Forces (UNAAF) (JCS PUB 2) (Washington: Joint Chiefs of Staff, October, 1974), p. 22. (Hereafter: JCS PUB-2).

60. Cutts and Buss, op. cit., p. 13 and Department of the Navy Instruction 2400,20B (OPNAVINST 2400.20B), "Management and Use of the Radio Frequency Spectrum within the Department of the Navy," p. 2 (Hereafter: OPNAVINST 2400.20B).

61. Webster's Third New International Dictionary, (Springfield, Massachusetts: 1961).

62. Aspen Institute for Humanistic Studies, Refocussing Government Communications Policy (Proceedings of Four Washington Staff Seminars held Winter-Spring 1976. Washington: Aspen Institute, 1976), p. 19.

63. Wheaton, op. cit., p. 33.

64. Schmitt, loc. cit.

65. Executive Office of the President, loc. cit.

66. Long range planning is defined by the author to be policy that is formulated not in response to current crises, but as a conscious shaping of future, anticipation and avoidance of crises and well thought out solutions to basic and immediate problems.

67. Thomas J. Houser, "Telecommunications Policy Formation Post OTP," Signal, (January, 1978), p. 27.

68. Victor G. Rosenblum, "Low Visibility Decision-Making By Administrative Agencies: The Problem of Radio Spectrum Allocation," The Administrative Law Review, 18 (Fall, 1965), p. 52.

69. Houser, loc. cit.

70. Ibid.

71. Martin C. J. Elton, "Government Telecommunications Research and Policy Research," Refocusing Government Communications Policy Proceedings of Four Washington Staff Seminars Held in Winter-Spring 1976 (Washington: Aspen Institute for Humanistic Studies, 1976), p. 19.

72. Part of the reason for the lack of specific "telecommunications" policy is that it may have been swallowed-up by a new term--information policy. An explanation of this term can be found in two articles entitled "Developing National Information Policies" by Arthur A. Bushkin and Jane H. Yurow and "Information Policy: Progress and Prospects" by Richard W. Neustadt in Library Journal, 15 September 1979.

73. Richard W. Neustadt, White House Policy Assistant Director, (speech to Federal Communications Bar Association, Washington, 19 December 1979). (Mimeographed).

74. Ibid.

75. Harvey J. Levin, The Invisible Resource: Use and Regulation of the Radio Spectrum (John-Hopkins, 1971), p. 57.

76. Ibid.

77. Neustadt, loc. cit.

78. ACP-190 US SUPP-1(B), op. cit., p. B-5.

79. NTIA Manual, op. cit., p. 4-1.

80. Woldman, op. cit., p. CRS-8.

81. Ibid., p. CRS-9.

82. NTIA Manual, op. cit., p. D-4.

83. Ibid., p. 1-10.

84. Ibid.

85. Ibid.

86. Ibid.

87. Ibid., p. 1-13.

88. ACP-190 US SUPP-1(B), op. cit., p. 2-6.

89. Ibid.

90. NTIA Manual, op. cit., p. 2-1.

91. OPNAVINST 2400.20B, op. cit., p. 3.

92. NTIA Manual, op. cit., p. 8-2.

93. OPNAVINST 2400-20B, op. cit., p. 1

94. Department of the Navy Instruction 5420.1E (OPNAVINST 5420,1E), "Navy Department Frequency Advisory Function Board," contains the Board's membership and function.

95. LtCol. J. J. Talbot, USAF, "Spectrum Management, An Uncoordinated Happening," (speech delivered at the Frequency Management Group Meeting, April 1979). (Mimoegraphed).

96. Defense Audit Service, op. cit., p. 8-9.

97. Joint Chiefs of Staff Memorandum for the Director for Communications-Electronics, Pacific Command, dated 30 July 1979, p. 4.

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11. Commanding Officer 1
Naval Communications Area Master Station
Eastern Pacific
Honolulu, Hawaii 96786
Attn: Bill Gardner

12. LCDR E. J. Sujdak, Jr. 1
Communications Officer
USS Mt. Whitney (LCC-20)
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